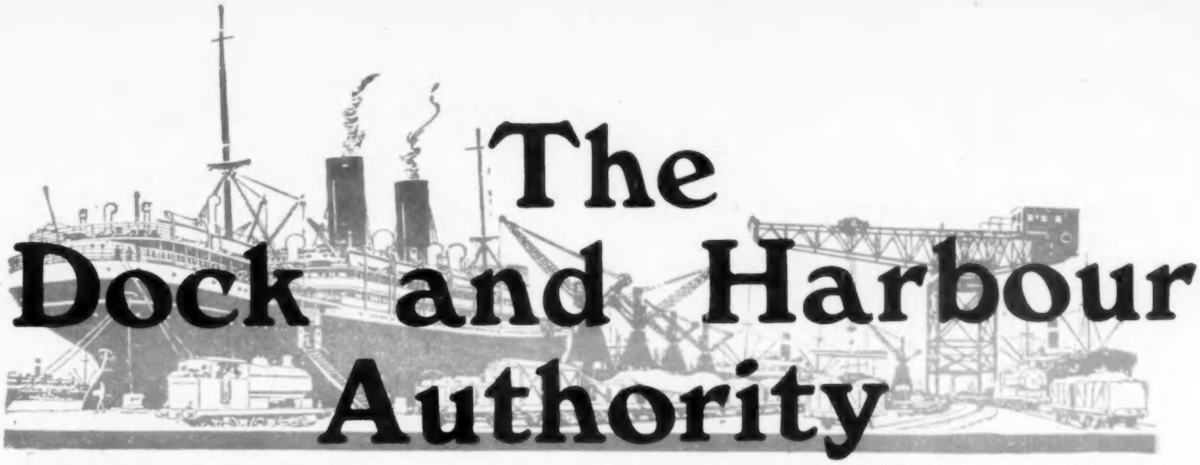


The Dock and Harbour Authority

No. 284. Vol. XXV. Edited by BRYSSON CUNNINGHAM, D.Sc. B.E., F.R.S.E., M.Inst.C.E. June, 1944

CONTENTS

Editorial Comments

A Spanish Slipway.

Slipways may conveniently be differentiated into two types or classes, according to the purpose for which they are designed. If employed solely for the launching of vessels following construction in a shipbuilding yard, they are essentially and simply sliding ways of timber set to a suitable inclination. Alternatively, if used for the purpose of carrying out repairs to, or for the overhaul of, craft, they have to be provided, in addition, with a stout cradle running on rail tracks and equipped with hauling gear, as a means of withdrawing vessels from the water.

Although designed for two such distinct, though collateral objects, there are features in common to both installations, mainly as regards the disposition of the ways or track, which must, of necessity, be based on a firm and unyielding foundation. Accordingly, questions of intensity of pressure and its distribution over the ground are of primary importance. It is for this reason that we have felt that it would be of interest to our readers to insert, and that they would appreciate an article on the construction of a large modern slipway. The leading article in this issue is an account translated from the Spanish of the design and construction of a launching slipway at the Port of Valencia, capable of sustaining a vessel of 24,000 tons, a weight which is certainly considerably in excess of the load normally placed on the cradle of a repairing slipway, but which none the less serves to illustrate certain important elements in slipway construction generally.

There are several specially interesting features in the Valencia slipway. It is founded on a bed of sand, artificially deposited and enclosed within retaining walls of sheet-piling, driven in the restricted area of a relatively small harbour, in close continuity to adjoining slipways, which inevitably produce wash and surging in their neighbourhood, when vessels are launched from them. Readers will observe how the area at disposal was utilised to the best advantage, and how, by means of careful calculation, the difficulties of the site were overcome in an economical manner. The Spanish Engineers responsible for the work, and the authorities of the Union Naval de Levante, S.A., are to be complimented on the ability and skill with which the enterprise has been undertaken and accomplished. The new slipway marks a considerable advance in the shipbuilding resources of the establishment, the three slipways hitherto in commission being adapted to vessels not exceeding 18,000 tons.

Dock Fires.

We have on previous occasions called the attention of our readers to the particular prevalence of fire hazards in dock areas and to the serious consequences which may ensue from a comparatively slight outbreak. No more striking object lesson could be given than that afforded by the disastrous conflagration which occurred in mid-April at the Port of Bombay, resulting in terrible devastation, not only within the dock area, but in the town itself. The death roll ran into several hundreds and included some prominent port officials, of whom the most notable were Lt.-Col. J. A. Sadler, the general manager and deputy chairman of the Port Trust and Mr. J. S. Nicholson, the dock master. On the material side, apart from the destruction of numerous buildings, some of which had actually to be demolished to arrest the progress of the fire, there was a serious loss of 55,000 tons of food grain, stored in warehouses and sheds.

How the fire originated is not precisely evident, conflicting accounts having been given which will, no doubt, be cleared up in the official enquiry now proceeding. It is reported that there was an explosion on board a ship in the harbour, apparently laden with munitions of war, and a fire, but whether the fire preceded, or followed, the explosion, and whether they both took place on the same ship is not explicitly stated in press accounts of the occurrence. In any case, the incident and its consequences have been of tremendous significance and almost beyond reckoning in terms of life and property.

Notwithstanding previous comments, we may be pardoned for bringing the matter forward once more. In fact, in a circular issued by the National Fire Service we have been urged to do so. The circular rightly and justifiably calls attention to the valuable services rendered by the N.F.S., and in reproducing the statement on a later page, we feel that it is but a slight recognition of the inestimable work done by a body of men who risk their lives as gallantly as soldiers on the battle field in combating a foe which is at once insidious and powerful. No effort can be spared by dockers and dock officials in any capacity and no precaution neglected to lesson the risk of an outbreak of fire in an environment which is susceptible of such disastrous expansion.

Port Administration Reform.

The article in this issue by Dr. Hannay-Thompson naturally inclines us—we might go so far as to say, impels us—to revert

Editorial Comments—continued

to the subect of Port Control, which we have already discussed in several previous issues. Port Administration, indeed, in its multitudinous forms presents so many facets and aspects that it is scarcely possible to deal adequately with them all in fragmentary comments. There is scope for quite a lengthy dissertation, and volumes have, in fact, been written on the subject both in this country and America. All that can be done within the compass of this Journal is to take some of the more prominent features and analyse them as succinctly as possible.

We have already pointed out the enormously wide range of interests which would be affected by any drastic or fundamental change in the existing system, or systems (for they are numerous) of port control and it is obvious, that very careful consideration must be given to the possible consequences of interference with the natural trend of business operations, as manifested in the present order of things. Like other convinced reformers, Dr. Hannay-Thompson strives for the attainment of an ideal. In accordance with the sentiments of Omar Khayyam, he would " grasp this sorry scheme of things entire, shatter it to bits and re-mould it nearer to the heart's desire." He proposes, in place of a conglomeration of independent, and sometimes conflicting, agencies, to substitute a Central Trust, whose duty it would be to acquire compulsorily all ports in the country from the authorities at present owning them and to administer them under a system of nation-wide public control. The Central Trust, he explains, through its control over the central funds could exercise a judicial faculty in deciding the rival claims of the different ports for new facilities or trades. And here we pause before going further, because we feel it desirable to put forward an obvious criticism. It seems to us that this proposed arrangement merely hides the cloven hoof of bureaucracy, and substitutes iron-handed officialdom for the free play of business influences. We cannot help asking whether, even if the ports themselves should prove amenable to the orders and directions of the Central Trust, individual shipowners and merchants would be equally complacent in accepting the official " routing of their trades in the most economical manner," of which, after all, as the parties most intimately concerned, they should themselves be the most competent judges.

It has been well said that the British people have a genius for successful compromise and adaptation to circumstances. Few, if any, of our native institutions are free from the charge of illogicality in some respect or other, and it must be admitted that the country has thriven on a policv of freedom for individual action. For this reason (apart from others) we do not think that the nation, with its age-old traditions and well-established usages, will ever take kindly to so rigid a framework as that proposed by Dr. Hannay-Thompson for its commercial enterprises.

We do not wish it to be inferred that we are totally opposed to combination and co-ordination of ports under joint authority. Such a step may, in certain circumstances, be eminently justifiable and advantageous. With a policy of local grouping in districts where trading interests are identical, or of the same nature, we are inclined to agree, as for instance in the coaling ports of South Wales, or those of the Northumbrian and Durham coalfields, or again in the fishery industry, or in the case of clustering ports in the same river, even including outlying coastal ports which act as feeders to a main port. But the forcible amalgamation of widely divergent shipping and commercial activities within a single central port administration would, in our view, involve (if it is to be really representative) the creation of a huge and unwieldy Board for the Central Trust, a large proportion of whose members might be totally ignorant about, and unsympathetic towards, some particular project of local importance, upon which a decision had to be made by the Board as a whole.

The space at our disposal in this issue is insufficient for further development of the argument. It is sufficient for the present purpose to have put the point forward so that readers may reflect on it while studying Dr. Hannay-Thompson's stimulating and thought-provoking essay.

Tyne-Solway Canal Scheme.

The agitation stirred up on behalf of the proposal for a Mid-Scotland Ship Canal has aroused interest in possible alternative schemes, and notably in one for a ship canal to connect the river Tyne with the Solway Firth. The suggestion has been discussed at the Port of Newcastle, where recently the Chairman of the Tyne Improvement Commission (Sir Arthur Sutherland), gave an address on the subject to the local Chamber of Commerce.

Sir Arthur pointed out that the proposal was first mooted at least 150 years ago, though it never got beyond designs on paper. One of these, prepared in 1883 by Mr. Watt Sandeman, is preserved in the offices of the Commission. It shows an artificial waterway extending for about 56 miles with a depth of 32-ft.

Sir Arthur condemned the whole idea. He said that a vessel coming across the Atlantic bound for Newcastle would not go to Silloth to come through a canal which would occupy nearly a day, for it would be much cheaper to come direct to the Tyne by sea. The same consideration would apply to vessels coming from the South—they would come up the English Channel.

He instanced a number of physical drawbacks and constructional difficulties inherent in the plan. " At the Silloth end there is only six feet at low water in the Solway Firth, which would mean that a deep-water channel would have to be dredged in the Solway as far as Maryport, a distance of about 28 miles; but the Solway Firth consists of shifting sand and this dredging would be very costly to keep the channel clear. I may say that we have to dredge out of the Tyne about 1½ to two million tons each year at a cost of about £78,000. We have about 15 miles of navigable channel and no shifting sands to contend with. Our Engineer is of opinion that to build the canal at the present time would cost nearly 200 million pounds, and if the canal were built, I doubt whether it would be of much use to shipowners."

Sir Arthur Sutherland was speaking, of course, from the standpoint of an overseas shipowner, and his criticism of the utility of the proposed canal, in so far as transatlantic and southern ocean voyages are concerned, is, no doubt, well founded. But it is scarcely the whole of the picture, and taking a more comprehensive survey, it may pertinently be asked how the coasting services would be affected. Would there not be a pronounced saving in time in the case of voyages to and from Liverpool, Manchester and Belfast, for instance, all of which ports run, or ran in normal times, services to the Tyne? Of course, there is the point that canal dues would be incurred and that these might negative, or, at any rate, appreciably discount the advantage of saving in time. Much would naturally depend on the capital cost of the scheme, for which the data are vague and uncertain. Also, there are strategic considerations which might carry weight from a National point of view.

Suggested National Harbour Board for Eire.

The financial straits into which certain ports in Southern Ireland have been driven by stress of circumstances, has led to the suggestion that there should be established a National Harbour Board for Eire. Senator Brennan has raised the question and it has been followed up by an article in the *Irish Times*, in which the following comment is made: " Certainly it is the duty of a far-seeing Government to see that all important ports are maintained in usable condition for future, if not for present, traffic; but may it not be necessary to go even further and place all such harbours permanently under National Administration? If our internal transport and shipping are to be State concerns, it is illogical to leave these termini of the shipping routes under local bodies. There can be little surprise if it is found later that an integral part of any scheme for Irish Shipping is a National Harbour Board." The suggestion is akin to the proposal for a Central Trust for British ports discussed in a previous comment.

Tidal Levels of the Thames.

In the present number is brought to a close the Paper by Mr. W. B. Hall on a very intriguing subject: the correct values of the datums in vogue in the Thames Estuary and, in particular, the precise level of that elusive and mysterious datum, Trinity High Water, generally called T.H.W. The ground he has covered is too wide for particularisation here, but the extent of his painstaking research is evident from the amount of information set out in his Paper, for which he deserves the highest credit. It will be of undoubted help to river engineers, especially in the London area.

The Construction of a Slipway for Vessels of 24,000 tons Displacement

*Important New Installation at the Port of Valencia**

By Engineer JUAN ANGULO.

THE demand, more insistent every day, for naval units constructed in accordance with modern developments in naval architecture, compels shipbuilding yards to make available the equipment necessary for their construction, especially, amongst other things, the provision of substantial slipways with dimensions conforming to requirements.

Among structures of this kind over which, as designer or constructor, I have exercised superintendence, stands out by its importance and rapid execution, Slipway No. IV of the Union Naval de Levante, S.A., at the Port of Valencia, which by reason of simplicity of arrangement, swiftness of execution and economy of outlay in comparison with other slipways of similar dimensions, may be, I believe, considered of interest to all my colleagues who are concerned in naval construction.

Actually, the Union Naval de Levante possesses in its establishment at Valencia, three slipways: one 142.95 metres (468 feet) by 23.40 metres (76-ft): another 128 metres (420 feet) by 20.40 metres (67 feet); and the third, 117 metres (384 feet) by 20.20 metres (66 feet). These permit of the construction of vessels and other naval units of a maximum displacement of 18,000 tons.

Dimensions of the New Slipway.

In order to increase the constructional potentiality of the yards up to units of 24,000 tons, the construction of Slipway No. IV was decided upon, in accordance with the following dimensions:

Length of the Slipway	180 metres (590-ft.)
Slope of Slipway	5.5 per cent.
Width of Upper Portion	25 metres (82-ft.)
Width of Lower Portion	28.2 metres (88-ft.)
Length of Apron	54 metres (177-ft.)
Slope of Apron	6 per cent.
Draught of Water at outer extremity	3 metres (10-ft.)

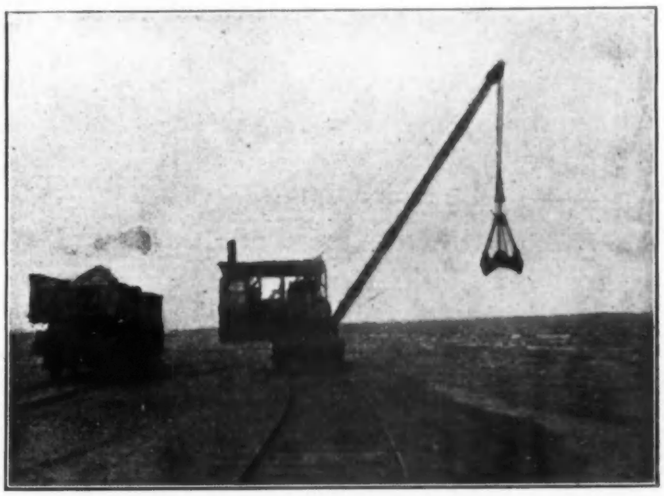
In the determination of these dimensions, advantage has been taken of experience gained in existing slipways and of the ingenuity of their designer, the late Engineer D. Justo Gonzalo, who striving for economy consistent with the stability of the work, carefully calculated the elements of greatest resistance, such as the bearing slabs under the keel-blocks and the launchways, treating them as lying afloat on the sand enclosed in a watertight compartment without possibility of escape. All this has been related in the *Revista* (issue of May, 1943) by the fluent pen of our colleague D. Salvador Canals, Engineer-director of the works.

In that article, in addition to a description of this orginal method of construction, was discussed the possibility of recourse to the trial of a reduced scale model, before deciding on the construction of the slipway in question in view of the problem which it displays; then, subsequently, our said colleague took note of slipways which had been constructed in the same relative position as those at Valencia, at various German yards (Bremerhaven, Hamburg, etc.), without there being any sign of disturbance by wave action due to wash from the launching of vessels; and, in view of this, the construction of the work about to be described was decided on.

The design of the new slipway had to be adjusted to suit existing conditions and like those already constructed it is founded on a sandy bed collected artificially. In the present instance the Union Naval de Levante did not command sufficient space within the limits of their establishment to provide a site exactly similar, so that it had to be projected as a salient into the waters of the harbour, and this afforded the advantage of testing the side of the salient as a utilisable pier of the same approximate length as the slipway, which had to be sufficiently substantial to resist the effect of wash which followed the launching of craft from adjacent slipways.

In Fig. 2 can be seen a plan of the slipway, formed schematically by a wateright enclosure of sheet-piling, preventing the escape of the accumulated sand, on which rests the slipway proper, which can be resolved for calculation into the following structural elements:

Guide Walls of the Slipway;
Retaining Walls of the Slipway proper;
Foundation of keel-blocks and under launchways;
Auxiliary elements.



Excavation of Sand for Filling.

As a basis for purposes of calculation, the maximum permissible pressure on the sand filling is taken at 1 kilogramme per square centimetre (1 ton per sq. ft.), together with the curve of maximum reactions produced during the construction and launching of a vessel of the greatest dimensions. The technicians of the Naval Union de Levante have determined this curve which is reproduced in Fig. 1. For its calculation, the following characteristics of the largest vessel were adopted as typical.

Length between perpendiculars	160 metres (525-ft.)
Width over all	21 metres (69-ft.)
Depth of hold	16.15 metres (53-ft.)
Weight at moment of launching	9,500 tons
Draught forward	2.63 metres (8.6-ft.)
Draught aft	4.87 metres (16-ft.)
Length of Cradle (Cuna)	147 metres (482-ft.)
Slope of launchways	6 per cent.
Slope of Keel	5.5 per cent.

The width of track and ways was rendered necessary for conformity to a pressure on the lubricated surface of 2 kilogrammes per square centimetre.

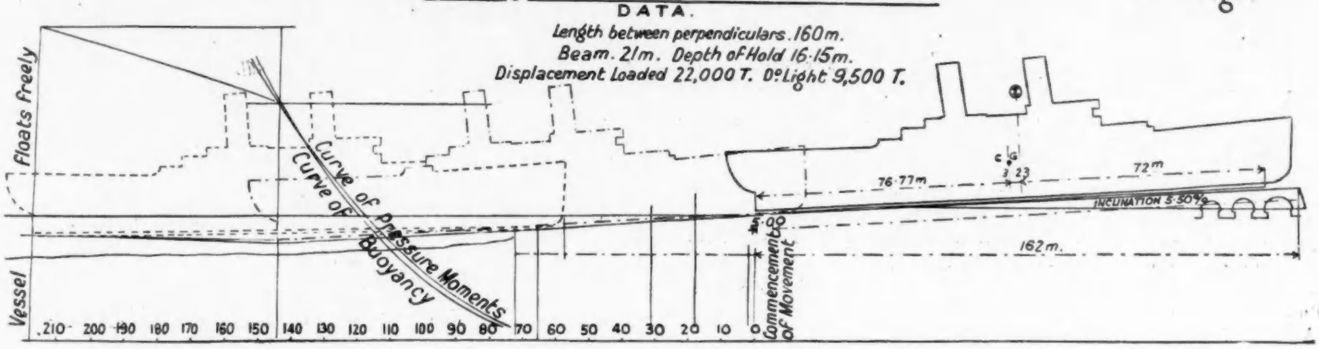
*Translated from the Spanish article in the *Revista de Obras Publicas*, November, 1943.

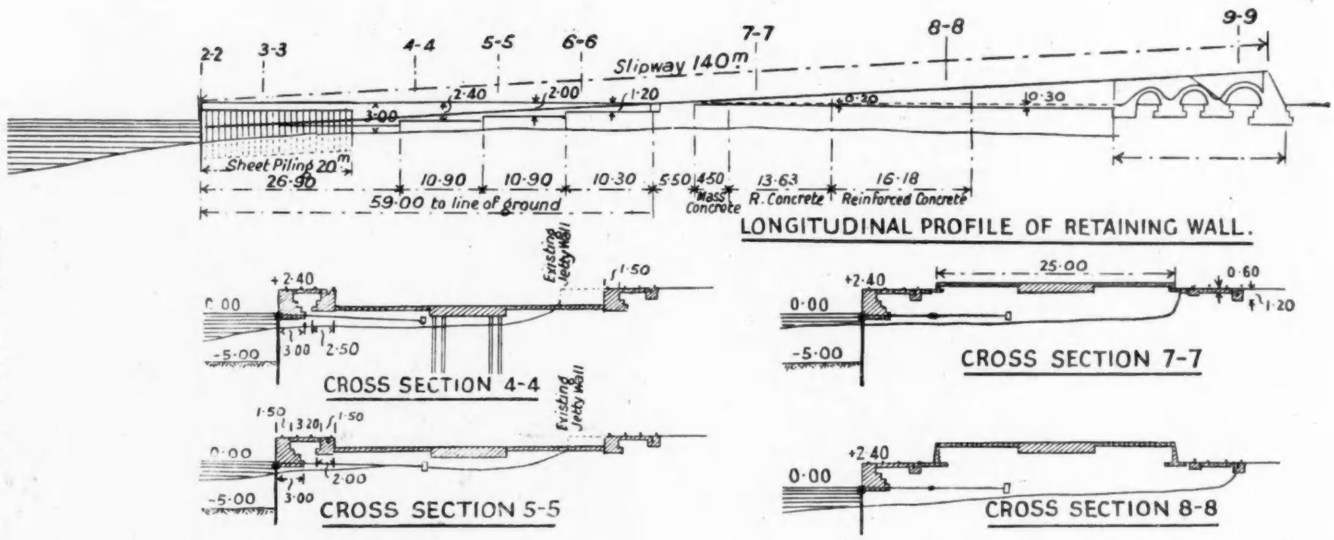
Construction of Slipway for Vessels of 24,000 tons Displacement—continued

SLIPWAY IV.

Launching Curves for a Vessel of 22,000 Tons

Fig. I





All movement due to surging of craft is counteracted by reason of the moment of pressure being always greater than the moment of surge; likewise the effect of plunge is annulled, the forward draught of 2.63 metres (8.6-ft.) being sufficient to support the vessel before its stern leaves the apron.

The greatest pressure is exerted at the beginning of the third stage; that is at the commencement of turning giving the lift a total value of 2,280 tons. It must be recognised that this load is distributed over a length of 9 metres (30-ft.).

The load of 2,280 tons, divided by 9 metres, is that which appears in the diagram. With safety, seeing that other vessels can experience the turn before or after that anticipated, it is permitted to consider this same loading spread over a length of 27 metres.

Descriptive Analysis of Design.

Having fixed the leading data for the design, we may proceed to a rapid review of the different elements in which the work is analysed for its investigation, dealing only with those features of importance for calculation without paying attention to matters which in the interests of simplicity present no complications needing investigation.

As previously stated, the guide walls which define the slipway entrance have been utilised as outfitting piers; they support cantilever cranes of high power and range, providing also berthage for vessels on the outer side with a draught of water alongside of 5 metres.

Since the bottom of the harbour on the site of the work is characterised by shallow depths, for economy in filling the natural profile of the ground was utilised and dredging was not undertaken until the close of operations, also by reason of urgency and the possibility of using the completed portion, sheet piling was employed to form the enclosure for the reception of the slipway. On that account the outer facing, front and interior side of the guide walls, up to the level 0.50, project from the base of sheet piling, treating this as a length of support by reason of its resistance to overturning in regard to that part which is entrenched to—5.00.

The lateral sheet piling united with the front forms a watertight compartment, easily emptied, which allows of the construction of the work in the dry and in all security. In it are driven the sheet piles, leaving 1 metre above the level of the water, and as soon as the slipway is constructed, the front sheeting comprised between the interior faces of the guide walls will be cut off by the blow-pipe, so that there will be no projection according to the design of the work. Before proceeding to this operation, a temporary sheeting will enclose the recess for the apron, making it possible to use the slipway during the formation of the latter, thereby gaining time very acceptable at the moment.

The sheeting piles are connected by walings of channel iron

Construction of Slipway for Vessels of 24,000 tons Displacement—continued

section from which radiate tie-bars of the form to be described. As in these latitudes there are no sensible tides, the zone of possible oxidation due to alternations of wetness and dryness is limited to about water surface level; the channels accordingly are set below and near zero level and the sand filling on which the work is founded rises to .50 metre below that level so in the case of the piles which are cut-off there is no risk of escape of the sand filling.

For the calculation of the piling section, the pile is assumed to be a beam bedded in the foundation and jointed at its junction with the tie bar, undergoing on account of the sand backing a uniform load over the quay due to the weight of the wall structure and a surcharge of one ton per square metre.

Accordingly, the following data are given for the purposes of calculation:

Depth of sea over embedded portion	h=5 metres
Height of filling adjacent to sheeting	h=5 metres
Natural slope of ground	38 degrees
Density of ground, submerged	d=1.2
Surcharge	p=6 tons per sq. metre

The slope and density are adopted from schemes previously studied at the port.

Having fixed the prisms of maximum pressure, of densities equivalent to the triangular section of earth and the rectangular section of surcharge with a height of 5 metres; having decided the law of variation of the bending moments and applying the theorem of Castigliano, there can be deduced the reaction in the tie bar, viz., V=4,125 tons per linear metre, the maximum absolute bending moment being positive M=6,486 metre tons and negative=9,225 metre-tons; so Larsen II sheet piling with a resistance moment of 1,100 cubic centimetres was selected.

The useful extent of thrust is fixed so that the moment of embedment is counteracted by the resistance of the bed against the part under stress and taking a factor of safety of about 30 per cent., this becomes fixed at 2.50 metres.

Having settled the reaction in the vicinity of the tie-bars, these are placed each 2 metres apart, arranged with circular section of 34 mm. dia. Their length is determined by the anchorage in a mass of joists situated at a distance from the sheeting such that the resistance offered by the ground exceeds the pull on the bars.

In consequence of the distance separating the tie-bars and of the stress in them, the waling channel or channels, stiffened by the sheeting are arranged in double ⊔ s of 150 by 70 m.m. with bolts of 21 mm. dia. each of 0.80 metres. The bars are furnished with their respective tightening pieces and joint plates.

Anchorage Block.

The dimensions of the anchorage block are calculated on the basis that the pressure transmitted to the ground may be .5 kg. per sq. cm., and the section capable of resisting the moment, assumed for the support, except for an opening equal to the distance between the bars, and subjected to a load of 4.5 tons per metre, equal to that determined in the calculation for the sheet piling as the reaction of the bars.

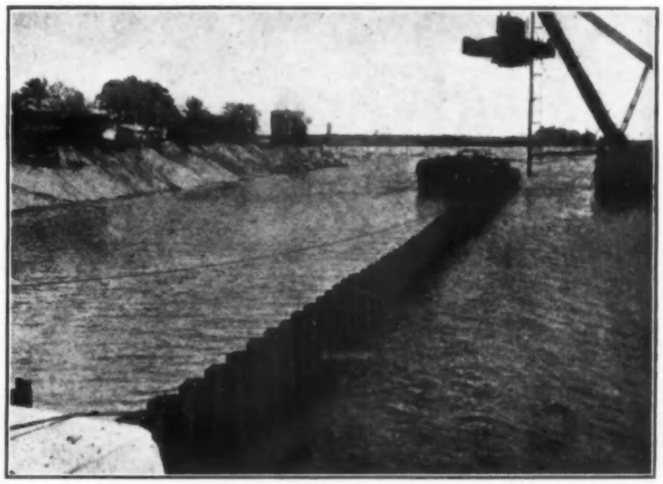
We select the rectangular section with 60 cm. width of base so that its height is fixed at 90 cm., which resists alone, without stiffening, the bending moment, except that to forestall tensions arising from settlements, and to give better distribution of tensile stress in the tie-bars, they are strengthened symmetrically with seven round bars of 10 mm. diameter.

Guide Walls.

The calculation of the guide walls utilised as an outfilling quay has been made on the most unfavourable hypothesis of the maximum overturning conditions and of greatest thrust. The wall resists in its interior portion the thrust of the filling, or of the water, directed outwards from within and due to the static and dynamic forces of the sea-water, directed in opposite senses, apart from the vertical loading due to the structure.

The most powerful thrusts due to water are those produced by the wave which has its origin in the launching of a vessel from the adjoining slipway and accordingly, to diminish its effect, the mole is oriented obliqeuly to the axis of slipway I and the calculation assumes that the waves inpringe normally thereto. In order to appreciate the magnitude of wave formation it may be stated that the floor of the harbour after it has been dredged affords in the neighbourhood of the work no debris nor other accumulations which can interfere with its movement, and that the immersion of a vessel produces a series of waves, the first of great magnitude, followed by others of less importance which recall in some degree the phenomenon of the three waves, very frequent in storms, such that at certain moments there is observed periodically an increase in height and violence of the waves, due to the interference of the original wave by its secondaries or harmonics.

In the first part of the work, seeking the most unfavourable situation it has been assumed that no filling exists, or rather the calculation has been assimilated to those for vertical breakwaters in accordance with the investigations of Sainflou, Benezet and Renaud, set out in full detail in the Reports presented to the XVIth International Congress of Navigation and the method of calculation of Sainflou has been followed as being the most exact.



View of Sheet Piling and Sand Filling.

The calculation of the stability of the wall is in agreement with hydrodynamic theory, or rather on the assumption that the wave does not produce shock in the wall through conversion of the molecular trajectories on reaching the frontage in straight lines.

We abstain from a demonstration of this calculation, which is shown in articles previously, published in the *Revista*.

The factors which form part of the determination of the pressure diagram are:

The length of the wave, $2d$ and its height, $2h$.

Any error in fixing the length does not materially affect the results of the calculation, seeing that an error of 50 per cent. in the assumption does not produce an error greater than 10 per cent. in the result.

On the other hand, errors of estimation in the height of the wave result in errors of great importance so that these have been fixed with much latitude on account of the lack of observed data.

Adopting the hypothesis that the wave breaks on a flat beach, in which the depth of water is one and a half times its height, in order to arrive at the height of the wave produced by the launching of a vessel from the adjoining slipway, let us recall the swell produced when waves have broken approximately some 25 metres from the adjacent Caro Mole in depths a little less than 3 metres, which justifies the assignment of 2 metres to the height of the wave in the worst case.

If as a margin of safety and allowing for the 3-wave pheno-

Construction of Slipway for Vessels of 24,000 tons Displacement—continued

menon, we increase the height by fifty per cent, there is indicated for purposes of calculation as wave characteristics:

Length $2d = 80$ metres; height, $2h = 3$ metres.

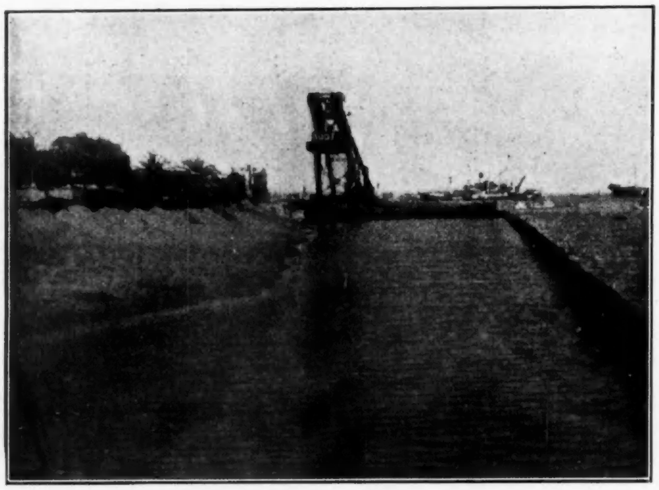
Having completed the pressure diagram, the maximum acting moment has a value of 80.09 metre-tons.

The resisting forces are those due to the weight and embedment of the sheet-piling; the total resultant of the forces, acting and resisting does not take into account traction nor loads in excess of those stipulated.

Having fixed the width of the wall at 6.20 metres, the height of the masonry is designed to reach 2.90 metres; the weight of walling, increased by that of the filling between its face and the bottom of the harbour, after the execution of dredging operations, and deducting the weight of the sheeting, gives a total load of 69 tons per lin. metre, exceeding the resultant for the centre of the central nucleus with a resisting moment of 214 metre tons.

The resistance to overturning due to the embedding of the sheeting for the useful length of thrust bearing is 40.62 metre tons, giving accordingly a total resisting moment of 254 metre tons.

The point of application of the resultant and opposing forces falls within the central nucleus at 2.52 metres from the intersection, considering compression only and applying the triangular law, it is clear that the pressures on the ground are less than the permissible limit.



General View of Enclosure.

The plane of the slipway on account of its inclination lies between the level of 2.40 m. and sea level, being bounded by the guide walls; above the top of these it is confined within walls which are founded on the filling and which are termed retaining walls of the slipway.

These are designed in reinforced concrete on a slab base which forms a wall, bedded in another of foundation in an endeavour to provide slender partitions so adhering to the solution adopted with the advantage of occupying little space and leaving the ground adjoining free for structures. Between these walls is arranged sand filling which supports the beam of the keel blocks and launchways.

The calculation of these walls presents no difficulty, being explained in full detail in treatises on reinforced concrete. In avoiding filling which by reason of its height could give rise to important settlements, the walls are raised until they attain a height of 3 metres, the remainder being designed as a system of factory vaults over which extends a covering of sand maintaining continuity of construction. Apart from the advantage indicated, the vaults allow in the appreciable area below the slipway the installation of compressors, electrical plant, etc.

The foundation of the keel blocks and launchways constitutes the most essential feature of the slipway, providing a bed for the ship during construction and support to the ways during launching.

In the pressure diagram are indicated separately the pressures on the keel blocks when the work in the slipway is considered completed and the maximum pressures on the ways in the different stages of launching; this has been done by dividing the bed in a longitudinal sense into different zones. which allow of the calculation as uniformly distributed pressures, the maxima permissible for the keel blocks and launchways.

Although, in the zone of the keel-blocks the load transmitted by these is that due to a series of pressures at stated distances equal to those between the blocks, the blocks have a width of 0.25 m. and are set to suit the main frames of a vessel, assuming that with the thickness of the slab and the distribution of pressure thereon, the loading is approximately in accordance with actual conditions, without appreciable error of calculation.

Bearing Piles.

Let us accept, as previously stated, a maximum resistance to pressure of the earth of 1 kilogramme per sq. cm. In those areas in which it may be exceeded there are bearing piles, calculated so that these unaided could support the increased load.

In view of the fact that the area in which the loading over the ways is greatest coincides with the third phase of launching, the ways are laid on piles as a protection against possible settlement of the ground which could produce disastrous consequences especially at the moment when a vessel is launched.

The work being designed in reinforced concrete, the upper and lower framings have been calculated independently on the basis of the maximum bending moments, positive and negative, derived, in the first case on the assumption of the ship resting on the keel-blocks and in the second case from the different phases of launching.

Simplifying the calculation in the manner indicated for the consideration of the case of the vessel resting on the keel-blocks, the loads assumed are taken as distributed uniformly over the width of the blocks or say, the maximum reaction due to the ship on the way in the portion considered is distributed throughout the width of the blocks, which are fixed at 1.50 m. and the other equal, uniformly distributed on the 8 metres which for constructional reasons has been assigned as the width of the bed plate, due to the same reaction of the weight of the vessel.

In considering the hypothesis of the ship on the ways, the stress due thereto is divided in equal parts on each of the two ways and the loads assumed in the calculation are deduced on the same supposition as in the earlier hypothesis.

Having settled in the loading, there is easily deducible therefrom all the data required to calculate thicknesses and framing in relation to the ground load taking into account also the inherent weight.

In zone 3, where the pressure on the ground is due to the loaded blocks lying within the determined limits; the consideration of the loaded ways does not follow the same lines, for these the bed plate resting on the piles capable of supporting the same load deduced for the ways as 127 tons per lin. metre assumes a load of 2,429 tons on the 27 metres of bedding.

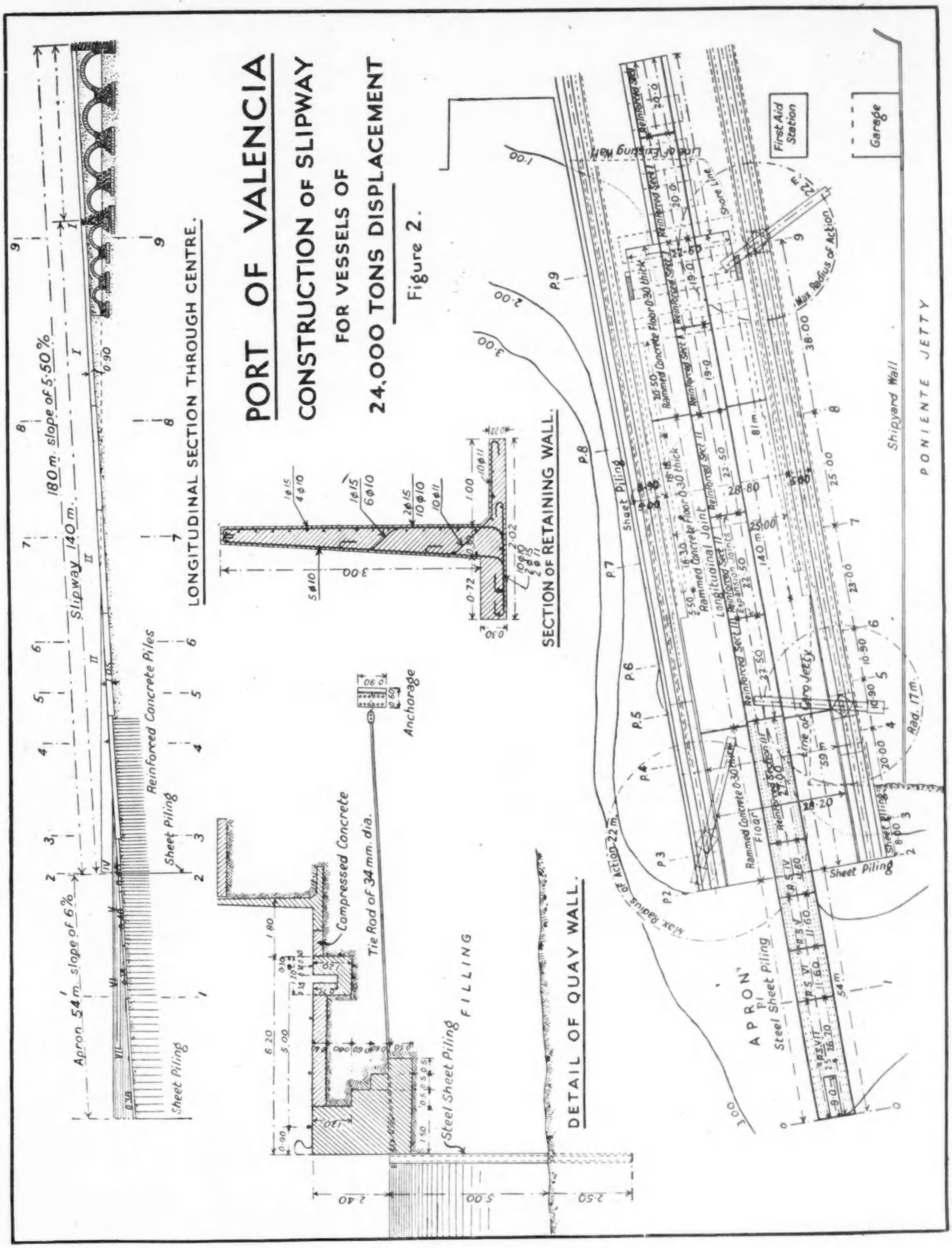
The platform which encloses the heads of the piles is calculated on the most unfavourable conditions for the loaded blocks; for this, the piles are assumed coincident with the extremities of the ways at 6 metres apart.

In zone 4 there are no blocks lying within the apron; piles are located there for reasons set out above, being calculated on the same basis as for zone No. 3.

For the calculation of the slab which embeds the heads of the piles it is assumed that there is a beam over these spaces resting on four supports, the outer portion subject to uniform loading aggregating the load on the ways and of the slab itself and the central space subject only to the weight of the latter.

In zones 5 and 6, the calculation is the same as before. In zone 7 though the loads transmitted are less than those permissible on the ground, yet for uniformity of construction and as a guard against settlement, piles are designed as in the previous case.

It has been taken into account that during construction in the dry the effect of uplift, compared with the imposed framing, calculated as aforesaid, is sufficient to resist the pressure.



PORT OF VALENCIA

CONSTRUCTION OF SLIPWAY FOR VESSELS OF 24,000 TONS DISPLACEMENT

Figure 2.

Construction of Slipway for Vessels of 24,000 tons Displacement—continued

The piles have been determined, taking account of the total load to be supported in each area on the assumption of a load of 36 tons on each pile. They are of square section 0.30 m. with a driving length of 6 metres comparable in resistance with the theory of M. Benabenq.

Cantilever Crane.

Of the auxiliary features of the slipway it is only necessary to allude to the supports of the track for the cantilever cranes.

There is assumed a 70 ton load per crane. The crane rests on rails through four sets of wheels, the distance between axes of these being 1.370 metres and 5.900 metres centre to centre for the same track.

Considering the support as essentially a base plate, reinforced with bars, in a form which maintains rigidity while distributing the load over the whole area of the base, it has a length equal to the distance between two uprights on the same side of the crane.

Supposing, in order to take the worst condition, the weight of the carriage is not distributed uniformly over the four supports but only over two supports, to the weight of 35 tons per support has to be added the vertical component of wind pressure, say 1 ton, to be on the safe side, making 36 tons as the compound load.

Taking the width of the plate as 1.20 m. and allowing for the above assumption, the pressure on the ground is 0.50 kilogrammes per sq. cm., which the filling is quite capable of supporting.

300-ton Crane Used for Driving the Sheet Piles.

The reaction of the ground on the beam in supporting this crane load, produces a bending moment, supposing the beam semi-embedded for its continuation with supports at distances equal to the centres of pressure.

In consequence, the depth of the beam is fixed at 0.60 m. with double a symmetrical reinforcement on the basis of 10 circular bars of 25 mm., above and the like number bars, 17 mm. in diameter, below.

For the distribution of the transverse forces stirrups of 6 mm. in dia. are inserted, 10 per lin. metre, forming independent circles with vertices in two consecutive bars.

It is agreed that the rigidity of the beam is sufficient to distribute the pressure over the length assigned of 5.90 metre, as well as in the direction of the width. In the transverse sense the angle of distribution has been taken at 45 degrees, the pressure being transmitted to the whole width of the base, seeing that the thickness of the plate is double its width.

In a longitudinal direction the track possesses an appreciable rigidity and contributes to the general rigidity by reason of which the length of the track extends its influence.

Adopting a rail section with resistance moment of 312 cu. cm., the length for consideration is 70 metres and assuming, as already stated, equitable distribution of pressure over the slab, the length affected is 190 metres; as it is claimed that the load on each vertical member is distributed over 590 metres, the support, in accordance with the calculation made by Zâffra in his " Mechanics " would have a moment of resistance of 14,400 cubic centimetres.

Taking the beam as 57.4 cm. of useful thickness and 1.20 m. wide, uniformly reinforced with ten rods of 17 mm., without reckoning the upper reinforcement of normal working loads of steel and concrete the slab possesses a moment of 14,270 metre kilogrammes, which is sensibly as calculated above.

Assignment of Contract with General Features.

Having held a competition among firms specialising in maritime works, the construction of works described above was allotted to the Sociedad Iberica de Construcciones y Obras Publicas, who carried out the whole of the constructional work at the Port of Valencia and who made the lowest tender.

The principal problem, due to present conditions, was the obtainment of materials, seeing that there were required 780 tons of sheet-piling, some 300 tons of steel of all kinds and 23,000 cubic metres of clean sand, as well as other materials in lesser quantities.

The sheet piles had to be imported and it is a matter for surprise that coming from a country engaged in war, their manufacture was excellent and the delivery rapid.

The sand filling was not procurable by dredging since, apart from the fact that the magnitude of the requirement did not justify the procedure, the sand on the sea floor of the coast adjoining Valencia was rather dirty, with a mixture of mud and seaweed. Accordingly it was decided to take it from a neighbouring beach characterised by surf, where the sand is clean and sea-washed; for this purpose small grabs mounted on cranes were used to tip the sand into tipping wagons of 10 cubic metres capacity with rail transport from the yards of the works undertaking to the harbour.

By this means a good reserve was built up and the fear dissipated that the work would be retarded through lack of filling.

For driving the 3,300 metres of sheet-piling the contractors made use of one of their largest floating craft, the crane *Hercules*, of 300 tons lifting capacity, reckoned one of the most powerful in the world, mounted on a large pontoon, and operated without being affected in any way by the surface water disturbance in the harbour. Moreover, the height of its jib suited the gear which guided the drop-hammer.

The hammer employed was a Demag Union VR 20, arranged for steam or compressed air drive; diameter of cylinder 275/340 mm., drop 400 mm., with rapid blows approximately 130 per minute.

Driving was executed on pairs of piles with the aid of a double helmet; the results were good, reaching 32 piles per day, equivalent to an advance of 15 metres in the same time.

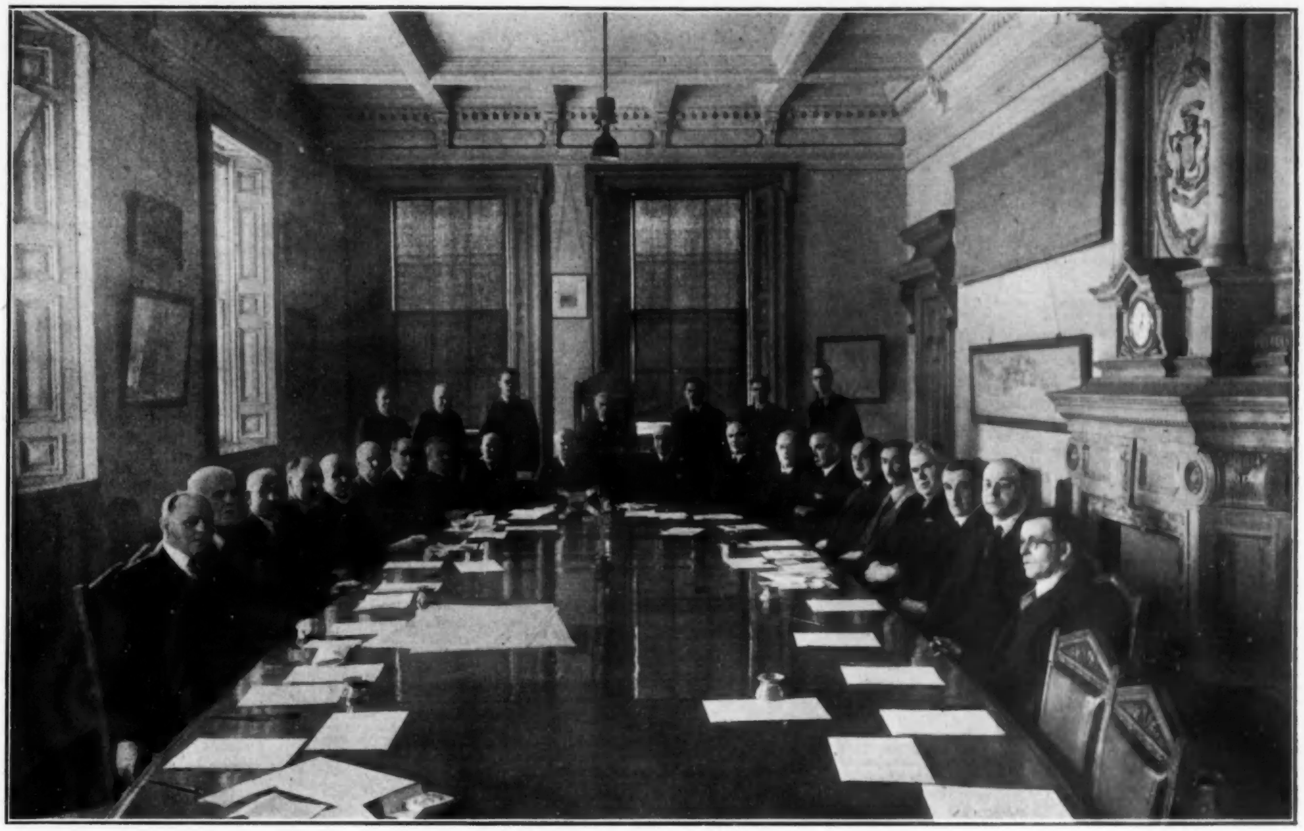
The estimated cost of the work, including the cost of the sheet-piling and the 17 per cent. increment on the contract was 4,900,000 pesetas in round figures.

New Inverness Harbourmaster.

Mr. John Maclean, assistant marine superintendent, has been appointed to the post of Harbour Master and Collector of Inverness Harbour.

Southampton Harbour Board.

The following appointments have been made to chairmanships of Committees by the Southampton Harbour Board:—Quays and Pier Committee—Councillor P. W. Blanchard; Works and Harbour Committee—Mr. M. G. J. McHaffie; Finance Committee—Mr. C. E. Cotterell. The Air Base Special Sub-Committee has been constituted as follows: Mr. H. A. Short (chairman of the Board); Alderman T. Lewis (deputy chairman); Mr. M. G. J. McHaffie (chairman of Committee); Mr. F. R. Alderwick; Commander J. Bird, Mr. C. E. Cotterell and Councillor R. J. Stranger. Lieut.-Col. G. Ackerley has resigned his membership of the Board on account of his inability, through service duties, to attend meetings.



The Board Room.

The Dundee Harbour Board

THROUGH the courtesy of the Dundee Harbour Trustees we are able to reproduce a photographic view of their Board Room, with the members in session at a recent meeting. The following is a list of the members present:

In the Chair:—Mr. H. Giles Walker, J.P. (Chairman of the Board).

Seated round the table in sequence from left to right:—Mr. Douglas M. Christie, J.P., Mr. Robert Blackwood, D.L., J.P., Mr. Joseph Barlow, Mr. A. Lickley Proctor, F.S.I., Mr. Ralph C. Cowper, J.P., Mr. Edgar P. Brown, J.P., Mr. Kenneth S. Malcolm, Rear-Admiral E. G. Robinson, V.C., Provost Alexander Smith, J.P. (Convenor of the Finance and Rights Committee), Mr. R. B. Graham (Deputy-Chairman of the Board), Colonel John B. Muir, C.B., D.S.O., D.L., J.P. (Convenor of the Works Committee), Mr. David Mudie, J.P. (Convenor of the Tay Ferries Committee), Mr. William Reid, M.B.E., D.L., J.P., Mr. Archibald Rettie, J.P. (Convenor of the Lighting and Buoying Committee), Mr. Alexander J. Stewart, J.P., Mr. W. H. Valentine, Mr. Henry Main, C.B.E., J.P., Mr. James Laird, Bailie Richard Fenton, J.P., and Mr. William O'Neill, J.P.

Standing at the far end of the room, in order from left to right:—Captain John Walker, A.I.N.A. (Harbourmaster), Mr. John D. Panton, C.A. (Treasurer), Mr. Norman A. Matheson, Assoc.M.Inst.C.E., A.M.I.Mech.E. (General Manager and Engineer), Mr. Andrew R. Young, W.S. (Clerk), Captain Leonard J. D. Whitelaw, A.I.N.A. (Superintendent of the Tay Ferries), and Mr. William D. Keay (Assistant to the Clerk).

The members who were unable to be present were:—Mr. J. B. Archer, D.L., J.P., Mr. J. J. Barrie, J.P., Lord Dean of Guild William Clark, J.P., Mr. J. R. Cowper, Mr. James Grant, J.P., Mr. J. Hubert Low, J.P., Major T. P. Douglas Murray, M.B.E., Mr James S. Nicoll, Sir Herbert K. Ogilvy, Bart., Mr. Archibald Powrie, J.P., Bailie W. J. Ross and Mr. C. B. Walker.

Constitution of the Board.

For the following statement respecting the Dundee Harbour Trustees and their offices, we are indebted to the Clerk (Mr. A. R. Young, W.S.).

The control and administration of the Port of Dundee, and the Lighting and Buoying of the waters of the estuary of the River Tay on which the Port is situated, are vested in a body corporate with perpetual succession and a common seal, known as "The Trustees of the Harbour of Dundee." The Trustees were first constituted on 17 June, 1830. The present Harbour Board was re-constituted in 1911 under "The Dundee Harbour and Tay Ferries Consolidation Act, 1911." The present Board has a membership of 33 and all the principal public bodies in the Dundee District are represented on it, viz.:—

Elected by the Dundee Corporation	8
Elected by the Guildry Incorporation of Dundee, the Nine Incorporated Trades of Dundee, and the Three United Trades of Dundee	2
Elected by the Angus County Council	4
Elected by the Chamber of Commerce, Dundee	6
Elected by the Shipowners at Dundee	4
Elected by the Harbour Ratepayers at Dundee	6
Elected by the Municipal Electors	2
Elected by the Admiralty as their representative	1
	33

The Trustees are elected for a period of three years and are eligible for re-election. During the War period the triennial elections are suspended in common with the Municipal Elections under the provisions of "The Chartered and Other Bodies (Temporary Provisions) Act, 1939." The present Chairman, Mr. H. Giles Walker, who has served continuously on the Board since

Dundee Harbour Board—continued

1911, has held the office of Chairman since 1932, and is the oldest serving member on the Board. Mr. Giles Walker is a director of Messrs. Jute Industries, Ltd., Dundee.

The Trustees also control the Tay Ferries service between Dundee and Newport (Fife), and also act as the Pilotage Authority for the Dundee Pilotage District.

The Board Room and Main Offices.

The Board Room, where the Trustees hold their meetings, is situated in the Harbour Chambers building, Dock Street, which also contains the main offices of the Trust. This building is adjacent to and forms part of the Custom House building in Dock Street, Dundee. In 1840, H.M. Customs and Excise decided to erect a new building to house the Customs and Excise offices at Dundee, and they approached the Harbour Trustees for a grant of ground at Dock Street, in the vicinity of the Harbour, for this purpose. The Trustees, at that time, had only a room and inferior accommodation for their offices at the Harbour, and the proposal was then made that the Trustees should build new offices in Dock Street, adjacent to the ground on which H.M. Customs and Excise desired to build their new offices. H.M. Customs and Excise agreed to a proposal by the Trustees that the two projects should be fused together and a joint building should be erected to a mutually approved design, and by the same contractor. On 9th June, 1841, the foundation stone of the new building was laid, and there was deposited in the stone an inscribed plate, and also glass jars containing various gold, silver and copper coins of the realm, lists of Harbour Trustees and other Public Bodies in Dundee, Minutes and other Records of the Trustees, and copies of various Publications. The building is of a handsome design with a portico in the Roman Doric style, and was finished in 1843, and provided excellent accommodation for H.M. Customs and Excise and the Harbour Trustees. The Harbour Trustees occupy the eastern wing of the building, which wing is known as the "Harbour Chambers." The remainder of the building is known as the "Custom House."

In 1881, the Trustees found their office accommodation for the Treasurer's staff to be inadequate to deal with the expanding business at Dundee, and an additional wing was built on to the Harbour Chambers at the eastern end of the building. Advantage was taken of this new wing to provide accommodation for a larger Board Room capable of seating the whole 33 Trustees round a single table. The photograph on the previous page shows this Board Room as it is to-day.

The Board Room is a spacious apartment on the first floor with good natural lighting from five case and sash windows. The walls are of plaster, painted a cream tone with a rough surface texture and finished at floor with a heavily moulded skirting. The floor is of oak, while the plaster ceiling which is ivory white is divided into panels by plaster ribs. These panels at one time were each filled with enriched plaster ornaments with a large recessed and decorated enrichment in the main centre panel, but when the room was redecorated in 1939 these ornaments were removed and the panels and ribs left plain, giving the room a more dignified appearance.

The whole of the woodwork is in oak and, where formerly it had been stained and varnished a dark tone, it is now a natural oak shade, wax polished.

Access to the room is by two panelled double swing doors, one from the passage and one from the Secretary's General Office. The doors and also the panelling to the windows have heavy bolection mouldings, with fielded panels to the windows, while bold moulded architraves surround both windows and doors, the latter being surmounted by heavy overdoors carried on carved brackets.

The heating is by low pressure hot water radiators, and prior to the redecoration, these radiators were concealed behind panelling with the cast iron grilles which enclosed the recesses below window sill level. These enclosing panels and grilles were removed, modern radiators installed, and the backs and sides of the recesses panelled in simple oak plywood.

A fireplace with cast iron dog grate occupies the centre of one of the long walls, the opening has a marble surround with tiled sides and back, and is surmounted by a massive oak mantelpiece and overmantel, the main panel of which has carved on it the Coat of Arms of the City of Dundee, and also contains a clock.

The artificial lighting is by two electric pendants,

The Board Room table is of oval shape, and is of polished oak, and is sufficiently large to enable the whole 33 members of the Harbour Board to sit round it in comfort. Polished oak desks are arranged at each side of the Chair for the use of the Harbour Officials. Polished oak tables are provided at the sides of the room for the use of the Press. Forty chairs upholstered in dark red leather are provided in the room. The Chairman's seat is of massive oak construction and mounted on a dais.

In 1936, the General Manager and Engineer's department required extra accommodation to house their expanding staff and a further wing was added to the south of the 1881 wing. These new offices house the General Manager and Engineer's private room, the Drawing Office, the main telephone switch board, new strong room accommodation, and the usual accommodation for the clerks. These new offices are handsomely furnished in modern office equipment and style, and rank second to none so far as office accommodation of Harbour authorities in the country is concerned.

Fire Hazards at Ports

The Work of the National Fire Service

The following statement of the special duties performed by the National Fire Service of this country in connection with British Ports has been received for publication:

In all the harbours of Britain where dangerous and vital war cargoes are being loaded and discharged special patrols of the National Fire Service guard the ships and docks night and day against fire. Every evening dispatch riders carry a list of the ships entering the harbour to the Fire Force Commander. The cargoes are divided into three classes: petrol and other inflammable goods, explosives and chemicals, and food and all other goods essential to the war effort. By this means the Commander gets a picture of the situation and can give orders instantly for the precautions to be made and the type and amount of equipment to be moved to the spot. Dispatch riders then convoy the men and appliances to the ships.

Throughout the country hundreds of ships are being guarded every night in this way, and in one large port between 30 and 50 fire crews are being used. Where explosive or inflammable goods are being handled the firemen wear rubber-soled boots to prevent sparks, and a strict system of fire patrols is maintained over the whole of the danger area. Oil-tankers being unloaded in midstream are covered by fire boats and officers specially selected because of their experience of ship's fires, carry out night and day inspections to ensure that sufficient protection is being provided.

Telephone lines are run from the danger points to the nearest fire station, so that reserves of men and equipment can be called quickly to an outbreak of fire, and owing to the closely knit organisation and mobility of the N.F.S., these reserves can be moved without weakening the protection of the surrounding district. These N.F.S. sentinels with the hoses perform their duties in exposed positions, often with little protection and amid dust, fumes and dirt, in darkness, and in all weathers, yet it is rarely that they are brought into the limelight because of a spectacular fire. Most outbreaks are put out before they reach such large proportions.

Recently fire broke out in a cargo of land mines, and the crates containing them were already charred and glowing, but, risking the danger of sudden explosion, the firemen, went in and quelled the flames, and the incident passed almost unnoticed. In another case fire broke out in the engine-room of a ship carrying explosives. Reinforcements were required, but until they arrived the firemen stayed on board and prevented the heat from reaching the explosives, thus stopping what would have been a disaster to the ship and her surroundings. Home Office reports show that the men are enthusiastic in their work, which they realise is vital to the war effort, and when fires break out they are fearless and quick in tackling them.

Notes of the Month

New Slipway at Haiti.

A slipway for vessels of 1,000 tons displacement has recently been constructed for the Haitian Government.

Elgin Harbour Board.

Messrs. A. Duthie, D. Gault and Wm. Thomson have been elected as coal-owners representatives on the Board of the Elgin and Lossiemouth Harbour Company.

New Port Terminal at Seattle.

A new terminal costing some three million dollars has just been completed at the Port of Seattle, Washington, U.S.A. It consists of a double pier or jetty, 980 feet long and 110 feet wide, with a 100 foot wide roadway between sheds which occupy the frontages of the pier; these are of earth filled construction. It is destined for operation by the United States Army.

Developments at the Port of Carthagena.

Improvements of some magnitude are reported to be in hand at the Spanish Naval Base of Carthagena including the construction of a dry dock capable to receiving the largest Spanish warships. Existing installations at the port are being enlarged, as also at Escombreras Bay. A new small harbour is in process of construction.

Tragic Death of Indian Port Officials.

Included in the death roll at the disastrous fire at the Port of Bombay, to which allusion is made elsewhere in this issue, were Lt.-Col. J. R. Sadler, C.B.E., R.E., the general manager and deputy chairman of the Bombay Port Trust and Mr. J. S. Nicholson, the dock-master. Col. Sadler, after railway experience in England, dating from 1910,and serivce in the Transportation Directorate in India, was appointed to his offices in the Bombay Port Trust at the end of 1942. He was awarded the C.B.E. (Military Division) in 1940.

Maintenance of British Fishery Harbours.

A question was recently asked in the House of Commons respecting the financial position and future prospects of British Fishery Harbours. Mr. Boothby enquired of the Chancellor of the Exchequer whether he would set up a Committee to examine the position and to make recommendations with the object of enabling such harbours as are essential to the efficient conduct of the white, herring and inshore fishing industries to be properly repaired, equipped and maintained after the war. In reply, on behalf of the Chancellor, Mr. T. Johnston, said that action was already being taken to enable the fishery harbours to be kept in proper repair, and that full particulars had been obtained of their financial position which would be kept in view in the framing of schemes for post-war development of the fishing industry. He added that further financial assistance would be forthcoming in cases where it was shown to be necessary.

Scottish Harbour Indebtedness.

The following is a statement of the outstanding loans of the various harbour bodies in the North-East of Scotland (except Peterhead) the finances of which were the subject of a recent Government White Paper.

	Total Amount Advanced £	Amount of Debt Outstanding March, 1943 £
Buckie Town Council	116,403	49,421
Burghead Town Council	8,168	7,928
Cromarty Harbour Trustees	1,535	741
Cullen Town Council	2,697	360
Elgin & Lossie Harbour Co.	14,860	14,309
Findochty Town Council	2,000	2,000
Fraserburgh Harbour Commissioners ...	45,497	44,060
Gardenstown Harbour Trustees	3,552	650
Lossie Old Harbour Commissioners ...	10,684	9,303
Macduff Town Council	46,359	45,861
Stonehaven Harbour Trustees	7,000	566
Wick Harbour Trustees	85,787	65,431

Port Hostels for Colonial Seamen.

There are already four hostels for Colonial seamen provided at the ports of Cardiff, Liverpool, North Shields and London. It is now proposed to establish a fifth at Manchester. All the hostels are run by the Welfare Department of the Colonial Office.

Death of Retired Harbour Officials.

The death has occurred at Durban, South Africa, of Captain John Rainnie, Harbourmaster at Grangemouth from 1897 to 1903.

The death has also occurred in Edinburgh of Captain Charles M'Lean Cairns, a former dockmaster for ten years at Leith.

Proposed Seaplane Base at Cobh.

The Cork Harbour Board jointly with the Cobh (Queenstown) Development Association has had under consideration the establishment of a sea-plane base in the harbour, together with a free port area and also a quay capable of accommodating large liners. The Board was empowered to urge the Eire Government to examine the proposals, the seaplane base project having already been approved .

Undisclosed Port Developments at Durban.

Issues of the *Natal Mercury*, which have just come to hand, allege that unnecessary secrecy has been observed over certain harbour development works carried out recently, and that the Harbour Advisory Board has failed to notify them to the City Council, through their representatives who sit on the Board. The matter has been brought to the notice of Mr. F. C. Sturrock, the Minister of Transport in the South African Government, who has replied that, except as regards military secrets, the fullest information on such matters is available to the constituent bodies electing representatives to the Board.

Conditions of Service of Tyne Docks Police.

At a meeting, in May, of the Tyne Improvement Commission, a report was presented by the Police Committee in reference to a deputation representating the Docks Police, which had waited on the Committee to call attention to matters affecting the conditions of service of the Docks and Piers Police. The recommendations made by the Committee included one that the decision arrived at by the Commissioners in 1941, relating to the provision of pensions for the Docks and Piers Police on similar lines to those for the River Police, be deferred for the duration of the war, and another, that no increase be granted in the existing scale of payments for attendance at fires. The Report was adopted.

Appointment of Port Director at Calcutta.

The Government of India announce that they have decided to create a new post at the Port of Calcutta—that of Director of the Port, whose function it will be to co-ordinate and control the various authorities concerned in the operation of the port. They have appointed to the position Mr. F. A. Pope, chief commercial manager of the London, Midland and Scottish Railway Company, whose services are being lent temporarily for the purpose. Mr. Pope, it is understood, is already on the way to India to take up his duties there.

New Dock Canteen at Avonmouth.

A new canteen at Avonmouth for the Bristol Port Authority has been in commission since March, when it was opened for service by the Lord Mayor of Bristol, Alderman F. C. Williams. At the opening ceremony, the Lord Mayor said that the excellent facilities provided for the men would, he hoped, become a permanent feature of post-war arrangements. The new canteen was built at a cost of £24,000, had accommodation for 500 in the main hall and 150 in the smaller rooms, with special facilities for boys under 18. It was staffed by 70 women, was open at all hours, and a good meal could be had for 10d. Other canteens, five at Avonmouth and two at Portishead, had accommodation for 1,700 men and during the past 2½ years £18,000 had been spent on their improvement.

The Evolution of Port Administration in Great Britain

A Retrospective and Prospective Survey

By J. H. HANNAY-THOMPSON, Ph.D., B.Sc., B.Com., M.Inst.C.E., M.Inst.T.*

Traffic Disorganisation Due to War.

In common with most other transport undertakings, the ports of Great Britain have been disorganised as a result of the war, and the traffic upon which they normally depended for their existence has frequently been diverted from its usual channels in accordance with the exigencies of the war situation. The cessation of hostilities will therefore find the ports in a condition far removed from normal, and it is certain that, when the war is over, there will again be a complete redistribution of trade. One cannot tell when this will be, but the present moment may be not inopportune for a consideration of the ports of this country as a whole, together with certain factors which lie in the background of all the problems of the ports of this country, and in particular the way in which the present system or systems of Port Administration in Great Britain have come into existence, so that any natural tendencies can be noted.

The coast-line of Great Britain is very long in comparison with its area, with the result that, judged by Continental standards, there is no part of the British Isles which is not in comparatively close proximity to the sea, while the natural wealth of the geographical features has led to the growth of over 280 ports or harbours, of which over 70 are of considerable commercial importance, while at least 10 are very large in comparison with the others. For the districts which they serve to overlap is the rule rather than the exception, and in peacetime, in most cases keen competition existed between them and there was little or no co-ordination of policy, and wide differences exist between the principles upon which they are administered and their financial objects.

Existing Systems of Administration.

A large majority of the major and medium-sized ports are administered as Public Trusts or Commissions on a non-profit earning basis, though the position of at least two, which are municipally-owned, is somewhat analogous. They are all completely independent and though non-profit earning, they are actuated by ordinary commercial principles, and keen competition exists between them, both on the question of rates and the provision of facilities, where their geographical situation enables them to compete for the same trades.

The second largest group of ports is that owned by the Railway Companies, which administer them primarily as parts of a profit earning concern. Competition between the ports owned by different Railway Companies and by the other ports is extremely keen, the ports being regarded primarily as feeders to the Railway system, out of which the profit is earned. The size of the ports in Railway ownership ranges from those of national importance down to small piers and fishing harbours of which there are a very large number. Their policies naturally are inter-related in a manner which is impossible between ports which are managed by independent Commissions, and, where they lie geographically adjacent to each other, they are administered as a unit, thereby eliminating wasteful competition, and, where alternative routes are available, enabling the most economic to be selected and developed.

The remaining type of administration is that of a Public or Private Company, trading for profit, and, with the exception of ports which are associated with canal or other undertakings, is confined to ports of relatively small size.

Port facilities are amongst the most expensive of Capital Works, and in general they are the least remunerative, while overseas trade is more casual and subject to fluctuations, due to variations in international policy and other circumstances outside the trader's control, than any other trade. As a consequence, the Statutory Trust grew up in this country, and it is the outcome of the peculiar conditions in the British Isles and a direct result of the conditions imposed as a result of the Industrial Revolution and the system of Parliamentary Government which exists in Great Britain, together with the laws governing public bodies and undertakings which have been in force for the past 150 years. The historical background must be kept in mind when considering Port Administration in this country, and in particular when looking to the past for guidance in the future.

Until the commencement of the Industrial Revolution over 150 years ago, most of the ports of Great Britain were in the hands of interests which were not primarily connected with shipping matters, such as Towns and Burghs, or by the local landowners, who managed them in their own interests and not in the interests of those who made use of the facilities provided. Further, most of the ports and works connected with them were in a dilapidated condition, and no resources were available to put them in good condition, even the Towns being unwilling that their citizens should bear the burden of their cost of maintenance; further, the system of limitation of liability for undertakings had not been devised.

Port Trusts.

With the rapid growth of shipping at the close of the Napoleonic Wars, those persons connected with shipping realised that they must take a hand in the management of their affairs, and arranged, with the approval of Parliament, to appoint Trustees or Commissioners to adminster the ports in the interests of those people—Traders, Shipowners, Shippers, Brokers and the like, who actually needed the facilities. The control of the larger ports was taken by special Act of Parliament from the hands of the private individuals or the towns which owned them and placed under public control in the hands of Trustees or Commissioners who were elected or appointed to represent the various interests concerned with the ports.

Many of these Acts are of considerable antiquity, amongst the earliest being those concerning the Port of Dundee, which was first taken out of the hands of the Town Council in 1815, and placed in the hands of Commissioners for 21 years, the Harbour finally being placed under Trustees in perpetuity in 1830.

By the end of the nineteenth century, nearly all the major ports, with the exception of those which had passed under Railway control and the Port of London, had adopted this form of management. Only in the Railway Companies could commercial undertakings of sufficient financial solidarity be found to construct and administer ports, and during the time when the larger ports were passing under public control, many of the Railway Companies either purchased or constructed ports of their own to act as feeders for their own systems and to ensure to those systems a steady and remunerative traffic resulting from our overseas trade. This acquisition of ports by the Railway Companies was a somewhat gradual process, and a group of ports of great strength and solidarity was thus created, a solidarity which became even more marked after the last war when the large number of Railway Companies were forced to amalgamate into the four big groups, taking with them their ports. At the same time, the Railway Companies were forced to embody in their systems many small ports which, though in reality port companies, had been given the form of statutory railway companies. In certain cases these ports, as already stated, have fallen into natural geographical groups, notably in South Wales, though in others there is no such geographical relationship.

During the nineteenth century, only in London did there appear to be sufficiently stable and large trade to enable the administration of ports to be carried out on an independent profit-earning basis, for about the year 1800 a new era commenced with the initiation of the present system of docks, which were constructed and owned by the different Dock Companies. The early docks proved an immediate success, showing a return of up to 10 per cent. upon the money invested, but the immediate result was the formation of further Dock Companies which provided somewhat better facilities, but which, by 1864, necessitated amalgamations on the part of the Dock Companies to reduce existing competition and to resist the threat of further competition from new docks. This extensive competition was continued, while the increase in

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Evolution of Port Administration in Great Britain—continued

the size of ships necessitated the construction of even more expensive docks in various parts of the London area, while the position of the docks was such that, to instance the East and West India Company, by 1887 it was unable to cover its working expenses and the nominal price of its Capital fell from £100 to £9.

Not only was there complete absence of unity of interest and control, but the docks themselves had no interest and control in the river and approach channel to the docks system, with the exception of a limited area near their entrances. Thus the rights of conservancy of the river channel had been vested first in the City of London, later in the Thames Conservancy Board, while the duties of Sanitary Authority were divided between the Corporation of London and the Metropolitan Borough Councils. Thus, as late as 1900, though almost every other port in Great Britain was under the control of one competent authority, in London the control was still in the hands of diverse numbers of bodies, namely, the competing Dock Companies, the private owners of wharves, the Thames Conservancy, the Trinity House and the City of London. During the next few years the whole position received the very careful consideration of Parliament, which finally led up to the passage of the Port of London Act in 1908, to co-ordinate the whole of the port activities within the London area, this Authority receiving its present Constitution in 1924.

In the post-war years, it is probable that a large expenditure of public money will be needed, not only to make good war damage, but to provide the most economical method of handling goods, and it may be to stimulate new trades which have hitherto been dormant either through neglect or a failure to appreciate their possibilities. If the position were to revert to that which existed in 1939, not only would there be the most keen and possibly uneconomic competition between ports which were striving either to regain trade which they had lost during the war or to retain trade which had come to them as a result of war conditions and for which perhaps special facilities had been provided, but there would be the most keen competition between the different ports putting rival schemes before the Government, which would in some way be bound to adjudicate between them and decide which of the rival schemes were worthy of support.

In wartime, the decision upon such matters is the natural function of the Ministry of Transport, but there may be some who consider the continuation of such functions in peacetime to be undesirable. At the same time there may be others who consider that the pre-war loose control exercised by Parliament through the need to promote Bills or Provisional Orders when ports have extensive new works under consideration, is insufficiently complete, owing to the difficulty of reviewing port problems as a whole when a succession of Bills are promoted, and also unduly cumbrous and involving undue delays in the sanctioning of works. It is therefore natural that many people interested in port affairs are devoting their minds to solutions of this problem, some by considering schemes of amalgamation or working agreements between ports which are geographically allied to each other, others by considering the problem as a whole, while being conscious of the extreme practical difficulties which beset any scheme of nation-wide port co-ordination.

Wars, more than anything else, hasten scientific research and the process of evolution in the institutions of this country. Increased speed of communication and the necessity for co-ordination of effort for war purposes, make it increasingly apparent that some measure of co-ordination of effort in peacetime is equally necessary, and it seems not unreasonable to suppose that a system of Port Administration in this country which would be more suited to its needs, is one which would be a continuance of the natural growth of free public control which has been pioneered in the realms of Port Administration and been operated most satisfactorily in some cases for more than 100 years.

Proposed Central Authority.

A study of the various systems of Port Administration which are in existence throughout the world, together with the probable future development of International Policy and the part played by the State in Foreign Trade, shows that there are certain principles which must be the basis of all Port Administration, in particular where a large and diverse trade is carried. There should be a Central Authority, nation-wide in its scope, which would have power to lay down the guiding principles of the port policy of this country, and to govern the general policy of the individual harbours. This body must be not only well-informed, but completely impartial in its decisions, and, owing to the magnitude of port works, the time they take to complete and their long life, it should be a body so constituted that it will have continuity of existence and be substantially independent of political influence of a party or transient nature. This Central Authority, which would be ultimately responsible to Parliament, should itself be responsible for and control the distribution of all port funds. It must be in a position to make decisions with moderate speed, to be aware of the possibilities of every port in the country, and, at the same time, it must be a responsible body. Those who direct the administration must have a highly specialised knowledge to enable them to solve the intricate technical and financial problems which Port Administration presents, or they must be in a position to pass a reasoned judgment upon such alternative propositions as may be placed before them by experts in the various fields covered by Port Administration. This Authority would thus treat all the ports of this country as parts of a whole. Individual ports should, under its jurisdiction, have a large measure of independence, particularly in local matters, while it would be an advantage if all were conducted upon similar lines.

This Central Authority, following upon the natural evolution of Port Administration, commenced over 100 years ago, should take the form of a Central Trust which could have the power to lay down the basic principles of Port Administration for the country, and to decide major issues of policy for each port and co-ordinate the efforts of all. Its functions should be judicial rather than administrative. All the financial powers and resources of the ports should be vested in it, and all Port Stock, Debts or Loans should be combined in a Central Capital Fund.

This Central Trust could take over many of the Governmental functions at present carried out by Parliament or Parliamentary Committee, thus saving the time of Members, which is occupied in considering local Bills and Provisional Orders, for more important Government work. Its decisions should be final and it should be administered upon the same principles as those at present governing the Trust Ports, and it should take over the property in the assets of all ports and assume all their liabilities by way of invested capital or loan debt.

As so many of the major ports already have a system of public ownership and control, albeit on a local basis, to unite these systems of local public control into a system of nation-wide public control would not involve any great change in principle.

It would be necessary for the Central Trust to compulsorily acquire all ports from the authorities at present owning them, but it would only be necessary for financial compensation to be given to ports, such as those owned by the Railway Companies and the small commercial companies, which are run for profit. No such compensation would be necessary in the case of Trust-owned Ports, which could be relieved of their existing debt in return for the acquisition of Trusteeship over their assets.

The Central Trust, through its control over the Central Funds, could exercise a judicial faculty in deciding the rival claims of the different ports for new facilities or trades. It would be able to see that such trades were routed in the most economical manner, and further that such new proposals as were put forward showed sufficient breadth of vision to be adequate for the anticipated requirements of the port for a considerable period, but, at the same time, were not in excess of those requirements, viewing the trade of the country as a whole. It would be in a position to construct new Harbour Works anywhere upon the country's coast-line, irrespective of local financial backing, and it could prevent the construction of obviously redundant facilities where ports were competing for the same trades. It would also have powers to require a port to improve its facilities to meet increasing trade, or in the event of their becoming obsolescent, or to close ports or portions of them which were out of date and working at a loss, when the trade could be handled more expeditiously elsewhere.

Evolution of Port Administration in Great Britain

(continued)

The Central Trust would have the power to lay down the basis upon which the rates levied in the individual ports should be fixed, but it should not fix the port's individual rates or concern itself with details of local administration.

Local Administration.

The local administration should be in the form of a Commission which would function in a manner generally similar to that in which the existing Commissions function, except that it would be responsible to the Central Trust, instead of to Parliament only, but it would confine its attention to affairs concerning its own port or group of ports, or such local minor ports as might be taken under its control.

The Commission would be responsible for the finance of its own port, i.e., for its working and maintenance and for the contribution of its quota to the revenue of the Central Trust. It would have powers to execute minor capital works and provide plant out of its revenues up to a figure to be pre-determined for each port. The sanction of the Central Trust would be required for all items in excess of this, or for which a grant would be needed from the Central Funds.

All the ports are at present completely financially independent of the Government, with the exception perhaps of Loans, and it is suggested that the Central Trust should be equally financially independent and self-supporting, though certain guarantees of Stock by the Government or Loans to assist individual harbours in the construction of new works, might be made, as was done after the last war to assist to provide post-war employment.

The formation of such a Central Trust would be but a further step in the natural progress of the evolution of Port Administration in this country. With the establishment of this principle, the task of mapping out a proposed constitution for membership of this Trust, and the constitution and co-relation of local Commissions under its jurisdiction, should not present insuperable difficulties, when the comparatively recent revolutionary changes, such as the Railway Amalgamations in 1921 and the formation of the London Passenger Transport Board, in addition to many measures of purely wartime control, are considered.

Port Difficulties in Eire

Serious Financial Situation

As already indicated in past issues the port authorities of Eire are finding themselves in a serious dilemma by reason of the dissimination, or cessation of their normal water-borne traffic. The aid of local government authorities has been invoked, and in the case of Galway, a special rate has been levied by the County Council to assist the finances of the port. At Cork, conditions have been so bad, in consequence of the suspension of the cross channel traffic, that a rumour got about that the Harbour Board intended to close the port. This is officially denied, but a special meeting of the Board has had under review various proposals put forward to tide over the crisis which it is hoped will not long continue. The meeting decided on an appeal to the Eirann Government for financial aid and also to confer with local authorities and merchants on ways and means for carrying on the essential work of the port.

Commandeering of Argentine Port Installations.

It is reported from Buenos Aires that the Argentine Government have issued a decree declaring all port installations in the country capable of being used to store, preserve and ship the grain harvests to be public utilities, whether or not concessions or temporary permits have been granted. Where necessary, the installations will be expropriated. Installations, flour mills and other industrial establishments engaged exclusively for industrial operations are exempted.

Notable Port Personalities

XLII—Mr. Leslie Roberts, C.B.E.

Mr. Leslie Roberts, General Manager, since 1936, of the Manchester Ship Canal Company, was born in 1896, the son of the late Mr. William Roberts.

Mr. LESLIE ROBERTS, C.B.E.

Following in the footsteps of his father, who was a director of the Leyland Line, he has spent his business life in shipping; first in London with the Atlantic Transport Line and later, in Liverpool, where he joined the staff of the White Star Line, becoming Assistant Manager. On the death of his father, he transferred to the Leyland Line, as one of the joint managers, and was appointed general manager in 1929. He also became chairman of Messrs. W. H. Stott and Company.

Mr. Roberts joined the staff of the Manchester Ship Canal Company as Deputy General Manager in October, 1934. Prior thereto, he was, in addition to the activities previously mentioned, a director of the Royal Mail Steam Packet Company, of the Pacific Steam Navigation Company and of the British and Foreign Marine Insurance Company. He represented the Liverpool Steamship Owners' Association on the Mersey Docks and Harbour Board and on the Chamber of Commerce Transport Committee.

Mr. Roberts succeeded to the General Managership of the Ship Canal Company in March, 1936. He was awarded the C.B.E. in the Birthday Honours List of June, 1942.

The Institution of Mechanical Engineers.

At a recent meeting, honorary membership of the Institution of Mechanical Engineers was conferred upon Mr. Asa Binns, Wh.Ex., a former Chief Engineer of the Port of London Authority, to whom he is now Consultant Engineer. Mr. Binns has taken a prominent part in the activities of the Institution and has promoted its interests in many directions, serving as Chairman of two important Committees, and as President for the years 1940-2. He is also a vice-president of the Institution of Civil Engineers and has contributed engineering papers to both bodies, some of which have been published in this Journal. He was Resident Engineer on the construction of the King George V Dock, opened in 1921.

The Design of Piled Structures

By P. GARDE-HANSEN, B.Sc.,
Assistant Manager, Christiani & Nielsen, Ltd.

(Continued from page 21)

Calculation of Pile-loads

The carrying capacities of single piles and pile-groups have been dealt with in the preceding observations, as their determination forms the first step in designing a piled structure. The next step is the determination of the number and distribution of piles required to support the loads to be transferred from the superstructure through the piles to the ground. Except in the case of piles parallel to the loads, it will generally be necessary to adopt the method of trial and error for the calculation of the number and distribution of the piles.

The principle of calculation to be described here may be called the "elastic principle," as it is based upon the assumption that the load on a pile and the displacement of the head when subjected to the load, are proportional, or: $P=k\times\lambda$ where P=load, k=constant and λ=displacement of head.

If the pile is supported at the point only, we have :—

$$P=\frac{E\times A\times\lambda}{s} \qquad (1)$$

where E=modulus of elasticity, A=area of cross section of pile, and s=length of pile.

If the pile also is supported by skin friction along the sides, we have :—

$$P=\frac{E\times A\times\lambda}{s_1} \qquad (2)$$

where s_1 is a constant which we will call the "compression length" of the pile—s_1 can only be determined by test. The absolute value of s_1 is not required to be known, as long as the relative values of s_1 for piles within a pile-group are known.

It may be argued that, as so little exact knowledge is to hand about the actual loads piles can support, there is no call for a mathematical theory for the calculation of the loads on the individual piles in a group. Such an argument is, however, without value as long as the piles within a pile-group have the same carrying capacity. The theory will in this case serve to design the pile-group in such a manner that all the piles within it are placed in a rational way and so that the maximum load in any one pile does not exceed that fixed as allowable. With the older and approximate methods of calculating pile loads it was often the case that some piles were overloaded while others were not utilised to their maximum capacity.

This is of course bad design, as *no structure is stronger than the weakest member*. If few failures have been caused through this, it is most likely due to the great factor of safety obtained by the application of the most generally used pile formulæ.

The principle of design to be developed is based on the following assumption :—

(1) The deformations of the piles are elastic.
(2) The deformations of the piles are proportional to their loads.
(3) The pier is infinitely rigid in proportion to the piles. (By pier is to be understood any superstructure carried by the piles.)
(4) All piles are parallel to the vertical plane in which the resultant of the superimposed loads is situated; in the following referred to as the resultant's plane.
(5) The pile-group is symetrical with regard to the resultant's plane.
(6) The piles are simply supported at both ends.

The theory can be extended to omit assumptions (4) and (6), but under almost all conditions met in the design of foundations for buildings and bridges and in wharf and jetty design, all six assumptions are justified—which can be proved by applying the extended theory to a few examples and comparing the results with those obtained when the above-mentioned assumptions are made. The variations are of the order of less than 10 per cent. and generally on the safe side.

Various typical foundations will now be treated.

Pile-groups with all piles parallel.

This type of pile-group can only, under the assumptions made above, sustain forces for which the resultant is parallel to the piles. Any resultant having a component parallel to the piles and another component normal to these, would cause the pile-group to collapse, as it is easily seen from Fig. 5.

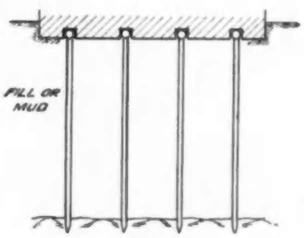


FIG 5

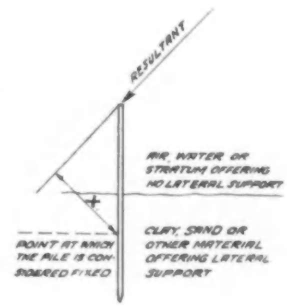


FIG 6

Assumption (6) is, however, seldom absolutely correct, and the piles are fixed to some degree at both ends. This is also necessary if a pile-group of parallel piles is required to sustain a force under an angle with the piles. These must then be assumed a fixed point somewhere between the underside of the pier and the pile point, and perhaps also in the pier. The latter assumption can for reinforced concrete piles quite easily be realised. The former assumption is frequently realised as mentioned previously, and how to determine the depth under the pier at which the piles may be assumed fixed has also been shown. In the case of piles driven through fill or mud to rock or a few feet into a good bearing stratum, it is, however, not permissible to consider the piles as fixed and assumption (6) above applies.

The condition obtaining in the case of piles simply supported at the top and fixed at the bottom are shown in Fig. 6, and piles of this type will have to be designed as columns supported and loaded as shown. It is obvious that the deeper the point in which the piles are considered fixed is below the underside of the pier, the more difficult it will be for the pile-group to sustain any loading not parallel to the piles. The design is quite simple, as it consists only in calculating the piles in regard to thrust and bending.

Pile-groups with piles at various angles.

When a load is superimposed on the pier, this will, on account of the elastic deformation of the piles, set up a movement infinitely small in proportion to the extension of the whole system. The displacement will be in the plane of the resultant.

It is known from mechanics and geometry that a movement is the result of a displacement of all particles of the body in parallel courses, or a rotation round an axis, or a combination of both.

If the resulting displacement can be found, the deformations of the piles and thereby their loads, can be calculated.

As it is assumed that the pier is infinitely rigid in proportion to the piles, no deformation takes place within the pier and the displacement is therefore a rotation only. To determine the

Design of Piled Structures—continued

displacement, it is sufficient to find two co-ordinates for the rotation axis' intersection with the resultant's plane and the angle of rotation. There is, therefore, in the three static conditions for equilibrium given enough to find the displacements and from these the pile-loads.

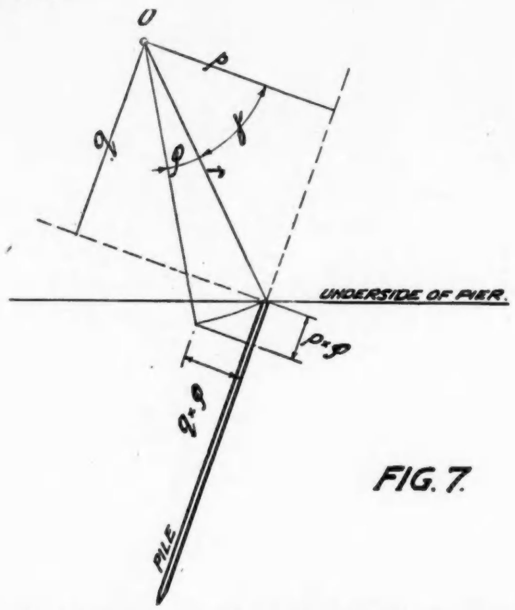


FIG. 7.

In Fig. 7, O denotes the rotation axis' intersection with the plane of the resultant, p and q its co-ordinates, and φ the angle of rotation. We have now that the component of the displacement in the direction of the pile is :—

$$\lambda = r\times\varphi\times\cos j = p\times\varphi \qquad (3)$$

and the component square to the pile

$$\lambda_1 = r\times\varphi\times\sin j = q\times\varphi \qquad (4)$$

and the load on the pile, see (2),

$$P=\frac{E\times A\times p\times\varphi}{s_1}$$

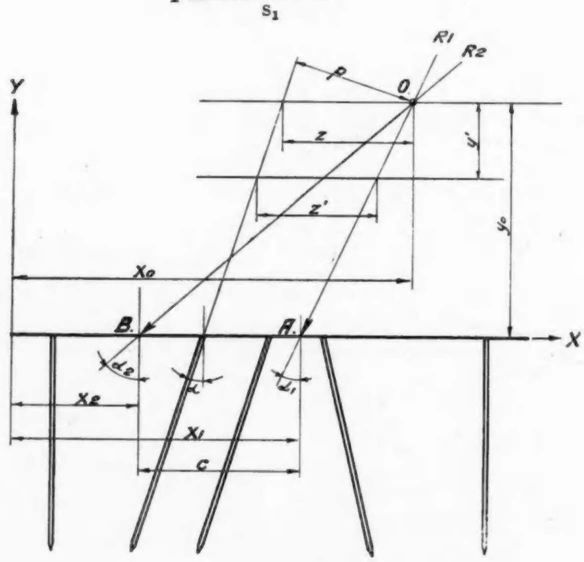


FIG. 8.

It has been mentioned that by means of the three conditions for equilibrium, the position of O and φ can be calculated.

As certain relations exist between special directions of forces and the corresponding rotation axis, it is possible to resolve the resultant force into such components that formulæ generally applicate for the pile-loads can be developed.

In Fig. 8 the angle α of a pile with the vertical is to be measured from the vertical and positive clockwise.

For a vertical displacement, 1, the pile-load will be :—

$$P=\frac{E\times A}{s_1}\times\cos\alpha$$

and calling

$$V=\frac{E\times A}{s_1}\times\cos^2\alpha \qquad (5)$$

we get .—

Vertical component of pile-load :—

$$P_v=\frac{E\times A}{s_1}\times\cos^2\alpha=V$$

Horizontal component of pile-load :—

$$P_h=\frac{E\times A}{s_1}\times\cos\alpha\times\sin\alpha=V\times\tan\alpha.$$

When R_1 denotes the resultant of all forces causing the vertical displacement, 1, of the pile-heads, we have for the vertical component of R_1 :

$R_1^v=\Sigma V$ and the point A in which R_1 intersects the underside of the pier is determined as the centre of gravity for the V^s.

We further have :—

$$R_1^v\times\tan\alpha_1=\Sigma V\times\tan\alpha$$

or

$$\tan\alpha_1=\frac{\Sigma V\times\tan\alpha}{\Sigma V} \qquad (6)$$

for the determination of the point of intersection of the resultant with the underside of the pier.

Similarly, will the intersection between R_1 and any plane parallel to the pier underside be the " centre of gravity " for the V^s acting in the intersections between the piles and this plane.

For a horizontal displacement, 1, of the pier, the pile-loads will be :—

$$P=\frac{E\times A}{s_1}\times\sin\alpha$$

from which :—

Vertical component of pile-load :—

$$P_v=\frac{E\times A}{s_1}\times\sin\alpha\times\cos\alpha=V\times\tan\alpha$$

Horizontal component of pile-load :—

$$P_h=\frac{E\times A}{s_1}\times\sin^2\alpha=V\times\tan^2\alpha.$$

When R_2 denotes the resultant of all forces causing the horizontal displacement, 1, of the pile-heads, we have in the same manner as above :—

$$\tan\alpha_2=\frac{\Sigma V\times\tan^2\alpha}{\Sigma V\times\tan\alpha} \qquad (7)$$

and B is the " centre of gravity " for the $V\times\tan\alpha^s$ acting in the intersections between the piles and the pier underside.

Similarly, will the intersection between R_2 and any plane parallel to the pier underside be the " centre of gravity " for the $V\times\tan\alpha^s$ acting in the intersections between the piles and this plane.

From the preceding, follows :—

(1) When the pier sustains a force in the direction of R_1, the resulting displacement will be vertical only, that is, the same as turning round a point infinitely distant in a horizontal direction.

(2) When the pier sustains a force in the direction of R_2, the resulting displacement will be horizontal only, that is, the same as turning round a point infinitely distant in a vertical direction.

(3) When the pier sustains a force in the same plane as R_1 and R_2 and going through O, the displacement will be a displacement of all particles of the pier in parallel paths, because the force can be resolved into two components in directions of R_1 and R_2 and the displacement will therefore consist of a vertical and a horizontal displacement only ; that is, the displacement is rotary, with an infinitely distant turning point.

(4) A moment, corresponding to a force in the infinitely distant line which is fixed by the two infinitely distant points on the R_1 line and the R_2 line, will cause a turning only of the pier round O.

Design of Piled Structures—continued

The last thesis is immediately obvious from the reciprocity between force and turning point, but can also be proved as follows :—

The rotation of a plane through O and parallel to the underside of the pier, will cause a pile-load with the vertical and horizontal components :—

$$P_L=\frac{E\times A}{s}\times p\times\varphi\times\cos\alpha=\varphi\times V\times Z \qquad (8)$$

$$P_v=\frac{E\times A}{s_1}\times p\times\varphi\times\sin\alpha=\varphi\times V\times Z\times\tan\alpha \qquad (9)$$

Z to be considered positive to the right of O and φ positive in the clockwise direction.

As O is situated both on R_1 and R_2 we have :—

$$\Sigma V\times Z\times\tan\alpha=O \text{ and } \Sigma V\times Z=O$$

because O is the "centre of gravity" for both the $V\times\tan\alpha^s$ and the V^s. From this follows that $\Sigma P_L=O$ and $\Sigma P_v=O$ as φ is constant. The resultant of the pile-loads will therefore be a moment, and φ is determined by :—

$$M=\Sigma\varphi\times V\times Z^2 \text{ or } \varphi=\frac{M}{\Sigma V\times Z^2}=\frac{M}{I}$$

where :—

$$I=\Sigma V\times Z^2.$$

This formula is of the same form as that for ordinary bending, but instead of unit of area we have $V=\frac{EA.}{s_1}\cos^2\alpha$.

The "moment of inertia" I with regard to O is the least possible that can occur in any horizontal plane with regard to any point in same.

The "moment of inertia" in an arbitrary plane (see Fig. 8) is :—

$$I=\Sigma V\times Z^{1^2}=\Sigma V\times Z^2+y^{1^2}\,\Sigma V\times(\tan\alpha-\tan\alpha_1)^2+2\times y^1\times\Sigma V\times Z\times(\tan\alpha-\tan\alpha_1)$$

as :—

$$Z^1=z+y^1\times(\tan\alpha-\tan\alpha_1).$$

In the equation for I the last factor is $=O$ as $\Sigma V\times Z\times\tan\alpha=O$ and $\Sigma V\times Z=O$ as shown previously. The first factor is a constant. Minimum I, therefore, occurs when the second factor is the least possible, and this is the case for $y'=o$, whereby the thesis has been proved. The thesis can also be formulated as follows :—

The O-point is the point in regard to which the "moment of inertia" of the piles is a minimum.

This property is as a rule sufficient for locating O. Generally we have, however (see Fig. 8) :—

$$X_0=X_1+y_0\times\tan\alpha_1, \text{ and } X_0=X_2+y_0\times\tan\alpha_2$$

or :—

$$y_0=\frac{c}{\tan\alpha_2-\tan\alpha_1} \text{ and } X_0=X_1+\frac{c\times\tan\alpha_1}{\tan\alpha_2-\tan\alpha_1}$$

where X_1, X_2, $\tan\alpha_1$ and $\tan\alpha_2$ can be calculated from the V^s and $V\times\tan\alpha^s$.

From $I=\frac{\Sigma EA}{S_1}\times p^2$ it is further seen that I is independent of the level and the angle of the underside of the pier.

As any load on the piles can be dissolved into a component in the R_1—line, a component in the R_2—line and a moment round O, we can by help of the preceding find the pile-loads. If the components of the resultant of all forces acting on the pier are called R_1 and R_2 and M, we have for the pile-load :—

$$P=\frac{1}{\cos\alpha}\times\left[R_1\times\frac{V}{\Sigma V}\times\cos\alpha_1+R_2\times\frac{V\times\tan\alpha}{\Sigma V\times\tan^2\alpha}\times\sin\alpha_2+M\times\frac{V\times Z}{I}\right]$$

because :—

A vertical moment, 1, causes pile-loads with vertical components V and a resultant component in the R_1—line$=\frac{\Sigma V}{\cos\alpha}$ A force R_1 in the R_1 line must, therefore, cause pile-loads with the vertical component :—

$$R_1\times\frac{V}{\Sigma V}\times\cos\alpha_1$$

Similarly must a force R_2 in the R_2—line causes pile-loads with vertical component :—

$$R_2\times\frac{V\times\tan\alpha}{\Sigma V\times\tan^2\alpha}\times\sin\alpha_2$$

A turning φ round O causes pile-loads with vertical components (see (8)) :—

$$\varphi\times V\times Z=\frac{M}{I}\times V\times Z$$

We can, instead of resolving the forces acting on the piles along the R_1—line and the R_2—line, resolve them along the vertical and the horizontal through O, calling the components respectively $\angle$ and H ; we have then :—

$$\angle=R_1\times\cos\alpha_1+R_2\times\cos\alpha_2$$
$$\text{and } H=R_1\times\sin\alpha_1+R_2\times\sin\alpha_2$$

from which :—

$$P=\frac{1}{\cos\alpha}\times\left[\angle\times\frac{V}{\Sigma V}\times\frac{\tan\alpha_2-\tan\alpha}{\tan\alpha_2-\tan\alpha_1}+H\times\frac{V}{\Sigma V\times\tan^2\alpha}\times\frac{\tan\alpha-\tan\alpha_1}{\tan\alpha_2-\tan\alpha_1}+M\times\frac{V\times Z}{I}\right] \qquad (10)$$

This formula can be considerably simplified for the cases most commonly met with in practice :—

1. *All piles parallel.*

As already shown, such pile-groups can only sustain forces in the direction of the piles. We therefore have $\alpha=\alpha_1=\alpha_2$ and R_2 or $H=O$ and :—

$$P=\angle\times\frac{V}{\Sigma V}+M\times\frac{V\times Z}{I}$$

if the pile-group contains *m* piles with the same s_1, and the same section, we have :—

$$P=\frac{1}{m}\times\angle+\frac{Z}{\Sigma Z^2}\times M$$

2. *The piles can be divided into two groups each with parallel piles.*

It is seen immediately that O is the intersection between the centre of gravity lines of the two groups as the "moment of inertia" of the piles with regard to this point is nil.

If the groups are driven under batters of respectively $\frac{1}{n_1}$ and $\frac{1}{n_2}$, we have $\tan\alpha_1=\frac{1}{n_1}$ for the one group and $\tan\alpha_2=\frac{1}{n_2}$ for the other group and $\frac{1}{\cos\alpha_1}=\frac{\sqrt{1+n_1^2}}{n_1}$ or $=\frac{\sqrt{1+n_2^2}}{n_2}$.

Denoting the two pile-groups r and l the general formula can now be reduced to :—

(11) and (12)

$$P_l=\angle\times\frac{\sqrt{1+n_1^2}}{n_1+n_2}\times\frac{V}{\Sigma_l V}+H\times\frac{n_2\times\sqrt{1+n_1^2}}{n_1+n_2}\times\frac{V}{\Sigma_l V}+M\times\frac{V\times Z}{I}\times\frac{\sqrt{1+n_1^2}}{n_1}$$

$$P_r=\angle\times\frac{\sqrt{1+n_2^2}}{n_1+n_2}\times\frac{V}{\Sigma_r V}-H\times\frac{n_1\times\sqrt{1+n_2^2}}{n_1+n_2}\times\frac{V}{\Sigma_r V}+M\times\frac{V\times Z}{I}\times\frac{\sqrt{1+n_2^2}}{n_2}$$

and if the piles in one group are vertical, i.e., $n_2=\infty$, we have for :— Batter piles :

$$P_l=H\times\sqrt{1+n^2}\times\frac{v}{\Sigma_l V}+M\times\frac{v\times Z}{I}\times\frac{\sqrt{1+n^2}}{n}$$

Vertical piles :

$$P_r=\angle\times\frac{v}{\Sigma_r V}-H\times n\times\frac{v}{\Sigma_r V}+M\times\frac{v\times Z}{I}$$

To assume the same A, E, and s_1 for all piles driven under the same batter within a pile-group is generally permissible, and

Design of Piled Structures—*continued*

corresponds to using the same size pile of the same material, and to assume that the specified set for all piles is obtained in the same depth. At the time of designing, no other assumption can generally be made. Should the result of the pile-driving show greatly varying results with regard to the length of the piles driven, the calculation may be checked, introducing the correct V^s, and the possible necessity for more piles can be detected before the pier is concreted.

3. *Pile-groups symmetrical with regard to a vertical plane normal to the plane of the resultant forces.*

In this case we have $\Sigma V \times \tan\alpha = O$, which again gives :—

$$\tan\alpha_1 = \frac{\Sigma V \times \tan\alpha}{\Sigma V} = O \text{ and } \tan\alpha_2 = \frac{\Sigma V \times \tan^2\alpha}{\Sigma V \times \tan\alpha} = \infty$$

or the R_1—line and R_2—line are respectively vertical and horizontal. The centre of gravity for the V^s is in the symmetry-line, and the centre of gravity for the v. tan α^s is infinitely distant.

O is on the symmetry-line, and the height above the underside of the pier is fixed by :—

$$Yo \times \Sigma V \times \tan^2\alpha + \Sigma V \times X \times \tan\alpha = O$$

which denotes that the moment round O of the pile-loads caused by a horizontal movement, 1, is=O, because the exterior force that would cause such a movement must lie on the R_2—line going through O. The equation can be written :—

$$Yo = -\frac{\Sigma V \times X \times \tan\alpha}{\Sigma V \times \tan^2\alpha}$$

and it is seen from this that Y_o is fixed by the batter piles only, because the vertical piles on account of the symmetry will neutralise each other in the summation. On account of the symmetry it is enough to consider the batter piles on one side of the axis of symmetry when calculating Y . If all these piles are parallel, we have tan α=constant and :—

$$Yo = -\frac{1}{\tan\alpha} \times \frac{\Sigma V \times X}{\Sigma V} = -\frac{Xa}{\tan\alpha}$$

where X_a is the distance from the symmetry line's intersection with the underside of the pier to the intersection between the latter and the " centre of gravity " line of the batter piles on one side of the symmetry line.

For the pile-loads generally we have from (10) :—

$$(13) \quad P = \frac{1}{\cos\alpha} \times \left[\angle \times \frac{V}{\Sigma V} + H \times \frac{V \times \tan\alpha}{\Sigma V \times \tan^2\alpha} + M \times \frac{V \times Z}{I} \right]$$

From this formula it is seen :—

(a) A horizontal force through O gives loads in the batter piles only, because tan α=O for the vertical piles.

(b) If there is only one row of batter piles on each side of the symmetry plane, a moment will give no load in these, because Z=O for all batter piles.

4. *All piles intersecting the same line square to the plane of the the resulting forces.*

In this case we have :— $I = \Sigma v \times Z^2 = O$ as Z=O for all piles. This means that $\varphi = \frac{M}{I} = \infty$ or that the pile-group is movable for a moment. The pile-group can therefore only sustain forces through O (the point in which the piles' intersection line intersects the plane of resulting forces). If the piles, however, are fixed in the bottom or in pier and bottom, they will be able to sustain a moment, if designed strong enough to take the bending moments caused by same.

We have discussed this previously for pile-groups with parallel piles only, and these are really a special case of the one dealt with here, namely, that where the piles' intersection line is the infinitely distant line in the direction of the piles.

(To be continued)

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this Journal should not be taken as an indication that they are necessarily available for export.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Dear Sir, **Post-War Water Transport**

It would be a tragedy if the publicity given to road and rail transport so overshadowed the claims of waterborne transport, that the prior claim to survival and development of our docks and waterways, coasting and overseas shipping, should fail to receive adequate consideration. What will it avail the internal transport business of this country, and how long could our proud position in the shipping world be supported, if trade and commerce dwindled because we failed to appreciate the advantage of waterborne carriage of our exports and imports? Our very existence rests upon seapower and that, ultimately, is maintained by our seafaring men.

Railways and Roads are essential links but they are only vital so long as our Merchant Navy can carry to and from the four corners of the Globe. Great Britain has probably more ports for its size than any industrial country in the World, but unfortunately many of these are struggling against fierce odds due to a variety of causes, but, in the main, to our economic system and stress of competition. I am pleading for a greater use of our waterways. It will avail little if I only succeed in rousing the enmity of any particular shipping or dock interest. I will try to " lay aside all prejudices and partial affections " and endeavour to avoid all possible occasion for quarrel even at some risk of misinterpretation of motives. I do feel, however, that our greatest asset in commerce, our most vital concern in peace and war, is primarily water transport. If I am right in assuming that the claims of docks, waterways, and shipping are superior to all others, it will be obvious that nothing should be left to caprice, or that any particular interest should be allowed to influence the general well-being of our docks and shipping.

Frankly, I cannot see how all the machinery necessary to the national development of our waterways and harbours can be provided, or function so long as there is no real effort made to distribute trade over the ports in such proportion as to justify the authorities concerned to spend money on transit sheds, terminal facilities, road and rail accommodation and standage, mechanical handling equipment, such as mobile floating and light and heavy fixed cranes and the like. The cost of provision of these facilities and all the work of maintaining the channels and moorings is divided over ships and shippers alike, but when the income from dues paid is totally inadequate the port languishes and may fall into disuse.

There is no question that many of our ports are capable of vast improvement, but there can be no justification for the expenditure of large capital sums unless there is some reasonable possibility of recoupment. Our shipowners and our manufacturing exporters are always facing foreign competition—a competition which alas can only be appreciated by those who try to understand the effect of lowered standards of living—expressed in wages, subsidies, tariffs and the like on our international trade, and commerce, and may be these and other very cogent considerations influence the policy of shipowners, but even so much might be attributed to purely domestic policy and rivalry.

It was stated (vide final report Royal Commission on Transport) that nearly half the population of Great Britain is concentrated near the large ports; further that the bulk of our exports and of the return cargoes of food and materials, passed through twelve ports because only this number were in a position to accommodate large ocean liners. I believe that this number is a generous one, having regard to total tonnage of materials using the ports, but the point is that Sir Norman Hill referred to them as bottle necks.

Is it not possible for all concerned to look at the problem from the point of view of national well-being and to cement a lasting alliance between shipowners and dock owners to ensure the prosperity of our export Trade, to stabilize industry and labour, to distribute our storage accommodation and so avoid the danger of wholesale destruction of food and other supplies, concentrated in or around a small number of shipping centres, and provide a greater number of refuges for our ships in time of war?

Yours faithfully,

May 15th, 1944. ALEX R. POLSON, M.Inst.T., F.R.S.A.

Tidal Levels of the Thames

The Origin and History of Trinity High Water†

By Wm. B. HALL, M.Inst.C.E.*

(*Concluded from page* 16)

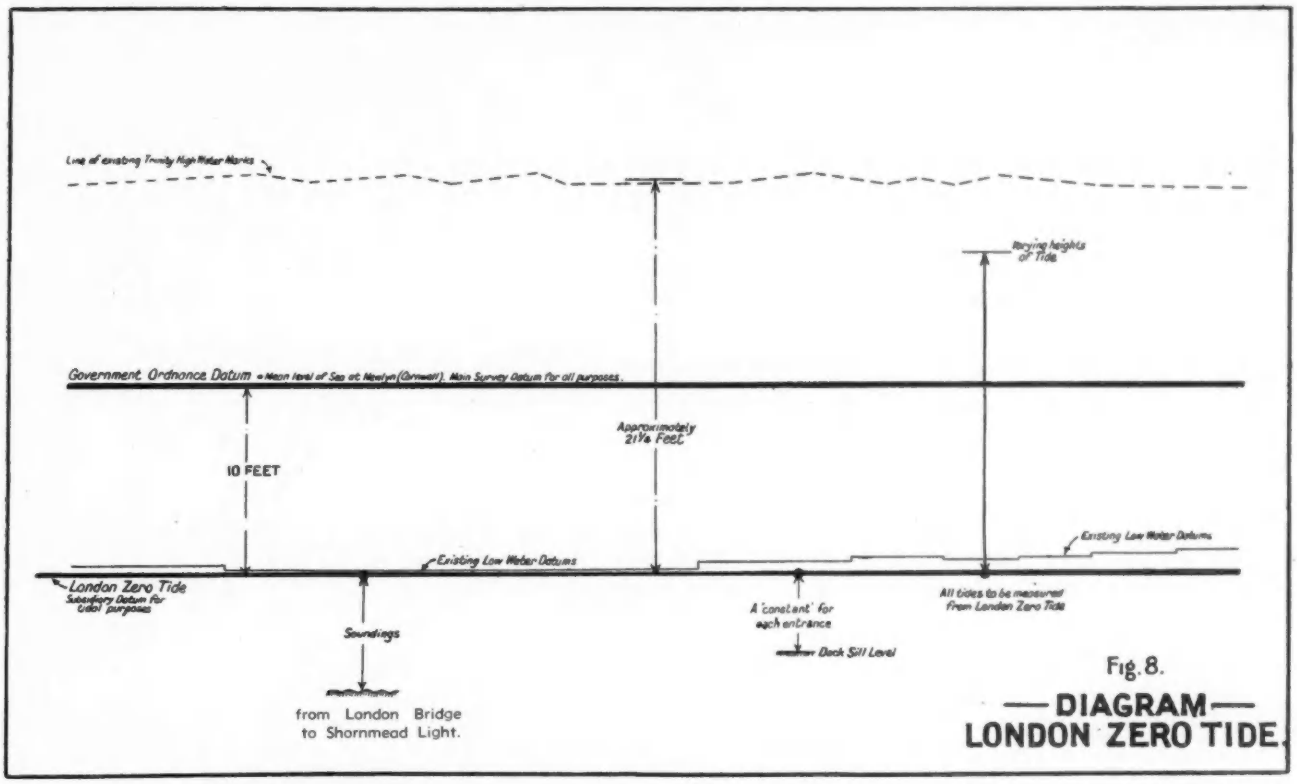


Fig. 8.
—DIAGRAM—
LONDON ZERO TIDE.

LONDON ZERO TIDE.

In the following pages the application of London Zero Tide to all branches of survey work is discussed in detail and its superiority to the present system is clearly shewn.

1. River Charts. London Bridge to Shornmead Light.

This portion, 30 miles in length, is the busiest and most important part, from a navigational aspect, of the River Thames and comprises all that narrow winding and historic channel which carries shipping, from the heart of London at London Bridge, to the open sea in the widening estuary of the Sea Reach.

Throughout the past century the hydrographic surveyors of this portion of the river have tried so various and so many low water datums that it would be tedious to relate them but for many years the official low water datums have been two:—

(1) From London Bridge to Deptford, 4 miles long, and from Broadness to Mucking Light, 10 miles long—Low Water Datum is 21-ft. 0in. below T.H.W.

(2) For the remaining 19 miles, from Deptford to Broadness —the Low Water Datum is 21-ft. 3-in. below T.H.W.

The setting up of two datums differing by only 3-in. in this stretch of river is apparently due to the mean low water at a certain point reaching a few inches below other points, but in view of the difficulty of taking soundings in a deep and swift river refinement of datum is altogether unnecessary.

†Paper submitted to the Institution of Civil Engineers and published in abstract in the Journal of the Institution. Reproduced by permission.
*Chief Draughtsman, Port of London Authority.

It is submitted that throughout the whole of this portion of the river, London Zero Tide exactly 10-ft. below Newlyn Datum would form a most suitable Low Water Datum for all navigational and tidal purposes. It may be tested as follows:—

(1) Zero Tide in this portion of the river is only from 1-in. to 5-in. lower in actual level than the existing datums. This slight alteration is in the direction of safety and cannot be challenged on the ground of adversely affecting the charts.

It has been found that the existing low water datums are, as stated above, only slightly above Zero Tide and could, therefore, be lowered safely to a uniform 10-ft.

(2) The Admiralty criterion that a datum "should be so low" that the tide seldom falls below it is also fulfilled in Zero Tide.

London Bridge—Levels	of Mean Low Water Spring Tides	=8.9	below N.D.
Galleons	do.	=9.2	,, ,,
Tilbury Docks	do.	=8.6	,, ,,
Mucking Light	do.	=8.3	,, ,,

From these figures it will be seen that very few tides, fewer indeed than fall below existing datums, will fall below the 10-ft. level or Zero Tide.

2. River Charts below Shornmead Light.

Below Shornmead Light the river rapidly widens out until at the Nore Light vessel, which is almost at the seaward limit of the Port, it joins the sea. The conditions in this stretch of river, termed the Sea Reach, and 21 miles long, are very nearly those

Tidal Levels of the Thames—continued

of the open sea and it is certainly not necessary to have extreme refinement in the levels of the Low Water Datums as neither surveyors nor pilots can work to small dimensions in such waters.

Existing Datums.

The Datums now in use in Sea Reach have been re-levelled and are found to be as follows:—

	Feet below Newlyn Datum
From Mucking Light to Thorney Creek ($4\frac{1}{2}$ miles)	9.08-ft.
From Thorney Creek to Crow Stone (4 miles) ...	9.17-ft.
From Crow Stone to West Shoebury Buoy ($3\frac{1}{2}$ miles)	8.9-ft.
From West Shoebury Buoy to Mid Shoebury Buoy (2 miles)	8.65-ft.
From Mid Shoebury Buoy to Seaward Limit (3 miles)	8.4-ft.

It appears unnecessary that this short stretch of river should have 5 datums differing from each other by such small amounts as 1-in. or even 3-in. It may be suggested that two Local Chart Datums, respectively 6-in. and 1-ft. above London Zero Tide, that is 9-ft. 6-in. and 9-ft. below Newlyn Datum, could be used, involving only negligible change in real level.

Comparison with existing datums.

The proposed slight rise from 9.17-ft. to 9.0-ft. at one place, that is only 2-ins., is negligible while the proposed slight drop of datum at the seaward limit from 8.4-ft. to 9.0-ft., that is only 7-ins., may also be considered negligible although in the direction of safety.

Comparison with Low Water Tides.

The only value available for the mean level of recent tides in Sea Reach is at Southend Pier, where the mean low water of spring tides is 7.85-ft. below Newlyn Datum.

The level of 9-ft. below Newlyn Datum for Local Chart Datum at Southend would, therefore, be 14-in. lower than those tides and in perfect agreement with the Admiralty practice of making the datum about a foot below Low Water of Spring Tides.

Comparison with Datum Levels in open sea.

At Maplin Lighthouse beyond the Nore and outside the Authority's jurisdiction the datum of soundings is approximately 8.37-ft. below Newlyn Datum that is $7\frac{1}{2}$-ins. above the suggested datum for Sea Reach. The latter datum would, therefore, agree quite closely with the datum used by the Admiralty Surveyors beyond the Nore.

3. River Charts above London Bridge.

The stretch of river between London Bridge and the landward limit at Teddington, 19 miles in length, is entirely different in its character from those mentioned in the previous paragraphs. There is a rapid rise in the level of low water from London Bridge up to Teddington and there are no less than 27 bridges, many with very low arches, to be considered.

It is not possible to adopt London Zero Tide as the chart datum throughout the whole of this length but it may be used most usefully as the standard of reference for the local chart datum. Present practice is to raise the chart datum by steps of 6-in. or 9-in. beginning at London Bridge until at Richmond it is 8-ft. 6-in. higher than at London Bridge.

It is suggested that from London Bridge to Blackfriars Bridge, Zero Tide should be the datum of soundings but above Blackfriars Bridge (or nearby) the datum should be 1-ft. above Zero Tide and so on, rising in steps of 6 or 12 inches until Richmond Bridge is reached, where Local Chart Datum would be 8-ft. 6-in. above London Zero Tide.

The variation in level from the existing datums would be negligible, the real alteration being a change in nomenclature by stating that Local Chart Datums are a given distance above Zero Tide instead of below Trinity High Water.

4. River Bridges.

As already stated, in the upper portion of the river there are 27 bridges, some with little headroom, and the height of these is a matter of extreme importance to those who bring large ships upstream.

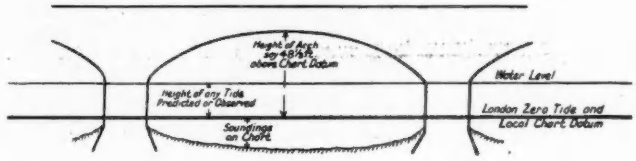
Hammersmith Bridge may be mentioned as an example. In publications it is said to have 15-ft. clearance above Trinity High Water but at spring tides there are only 12 or 13-ft. available.

There are no means by which the pilot may learn the height of the tide at the bridges (except in one or two cases) by direct observation and he is unable to estimate with any certainty and rapidity either the depth of water or the clear height of an arch at any moment as his vessel approaches a bridge. Both these defects could be remedied by a revision of the method of publishing particulars of the bridge and by providing a simple tide gauge at the more important bridges.

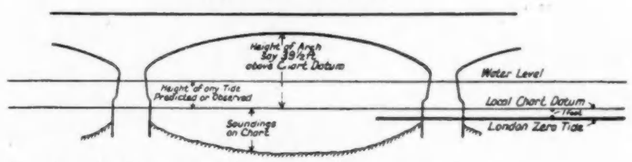
(1) Published heights of bridges, that is the clear height to the underside of the arch, should not be given from Trinity High Water, but from Local Chart Datum, which should be given as a height above London Zero Tide.

(2) The height of the tide should be observable, at least for a few bridges, by means of a tide gauge or board fixed to the bridge and easily read from a considerable distance. By deducting the height of the water given by this board from the height of the bridge given in publications, both having the same zero, the navigator would ascertain at once the clear height.

LONDON BRIDGE



WESTMINSTER BRIDGE



London Bridge may be taken as an example:—

(figures approximate)	Above Local Chart Datum
1. Local Chart Datum at London Bridge is London Zero Tide, i.e., 10-ft. below Newlyn Datum	
2. The clear height of the centre arch is	48-ft. 6-in.
3. The mean high water of spring tides is ...	22-ft. 9-in.
4. The mean high water of neap tides is	18-ft. 9-in.
5. The mean low water of neap tides is	3-ft. 0-in.
6. The mean low water of spring tides is	1-ft. 3-in.

With these few figures in his possession, and with the intermediate heights of the tide available at any time by observation from a tide gauge, and with soundings available on a chart the navigator is in possession of every material item of information required for the safe passage of his ship.

(1) If the passage is at high water spring tides it is simple to estimate:—

(a) Clear height of arch above water, by deducting the height 22-ft. 9-in. from the height 48-ft. 6-in. that is 25-ft. 9-in.

(b) Depth of water under arch, by adding the height 22-ft. 9-in. to the sounding, say 14-ft. 0-in., given in the chart, that is 36-ft. 9-in.

(2) If the passage is at any other time it is equally simple to deduct the reading on the tide gauge from the height 48-ft. 6-in. to obtain the clear height of the arch or to add it to the sounding on the chart to obtain the depth of water.

Ships using the upper part of the river have increased in recent years both in size and number and the masters of the large vessels may be sometimes in the dilemma that if they wait for **ample depth** of water before passing through a bridge, they

Tidal Levels of the Thames—continued

may find there is **too little clear height** under the bridge to give safe passage for their superstructure while if they have ample clear height, there may be too little depth of water and consequent risk of touching the river bottom.

The revision of the method of giving the necessary information to navigators, combined with the provision of a few easily read tide gauges would enable a shipmaster to judge the tidal position at bridges much more readily and accurately than at present.

5. Tide Gauges.

There are five automatic recording tide gauges maintained on the River Thames by the Port of London Authority.

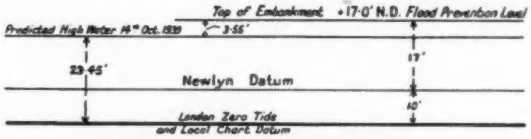
Richmond
Tower Pier
Galleons Entrance
Tilbury Docks
Southend Pier

These gauges were formerly set to Trinity High Water and the results must have reflected the errors of that datum. They are now, however, set to Newlyn Datum and the predicted tides, which are based upon these records, could readily be adjusted to a chart datum 10-ft. lower.

In addition to these, there are several tide boards and other visual gauges on the river. There should be no difficulty in setting the zero of these to Zero Tide or to any other chart datum.

6. Flood Prevention Levels.

Under the existing method of publishing tide predictions and other particulars the relation between any predicted tide and the levels of the flood embankment walls is needlessly obscure.



RIVER EMBANKMENT AT GALLIONS

The tides as published contain no dimension relating the zero of predictions to the Ordnance Datum, not even the height of Trinity High Water above Ordnance Datum. These two dimensions are essential if the degree of protection of any embankment is to be found and they ought to be given in tide tables.

By making London Zero Tide the zero of all predictions and by publishing the fact that it is exactly 10-ft. below Newlyn Datum the whole question of flood protection would be simple in the extreme.

A concrete example may be given.

Consider the protection given by the embankments at Galleons during the predicted tide of the 14th October, 1939.

	Feet
The height of the embankment according to London County Council requirements is 17.0-ft. above Newlyn Datum and, therefore, 27-ft. above Zero Tide	=27.0
Deduct the predicted tide, which is say 23.45-ft. above Zero Tide	=23.45
	3.55

There is, therefore, a margin of about 3-ft. 6-in. between the tide and the top of the embankment.

7. Dock Charts.

All charts of the Docks shew the depth of water below Trinity High Water.

Surrey Canal is an exception, all depths being shewn from a datum 3-ft. lower than T.H.W.

The entire arbitrariness of this datum for Dock Surveys is shewn by the fact that the dock water fluctuates to very great extremes both above and below it and the usual hydrographic rule that charts should shew the "least depth of water to be expected" is entirely ignored.

In St. Katharine Dock where the water level is not maintained by pumps, it fluctuates from each high tide to a level, between tides, frequently as low as 5-ft. below Trinity High Water. In these circumstances it seems irrational to give depths on the chart which are often 5-ft. greater than the actual depth.

In other docks the water is maintained by pumping, as much as 2-ft. 6-in. or 3-ft. 9-in. above Trinity High Water and seldom is lower than 1-ft. 6-in. or 2-ft. 6-in. above it.

In still another group of docks the water is kept at about Trinity High Water and may fall a foot below it between tides.

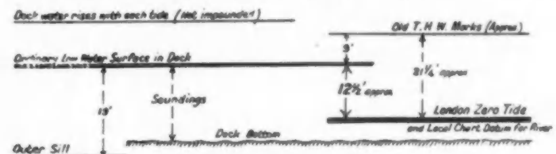
The use of Trinity High Water as a datum for all docks in spite of such large variations is, of course, only an extension of the idea of a "Standard Tide of 18-ft." established in 1800 at London Docks. There is no sound reason why each dock system should not have its own carefully selected datum of soundings giving a much truer picture of the depths to be expected in each dock. Such datum would first of all be related to London Zero Tide to provide a complete connection between all levels in the River and in the Docks. But it may also be related, for the sake of those who still desire to use the various T.H.W. marks in the Docks, to what may be called an approximate Trinity High Water. The writer recognises that there are many who are so accustomed to relating everything to Trinity High Water that they will continue to do so for some time and until they are familiar with the idea of a standard Low Water Datum. The old and well used marks throughout the docks, even if they are too inaccurate for modern surveying practice do fulfil a useful purpose and they might well be left to form an approximate guide to the height of the water in the docks.

It would be sufficiently accurate for all dock purposes to say that Trinity High Water is now recognised approximately as a high tide $21\frac{1}{4}$-ft. above London Zero Tide or conversely that all tides reaching $21\frac{1}{4}$-ft. above London Zero Tides are Trinity Tides and touch (or nearly so) the old T.H.W. marks.

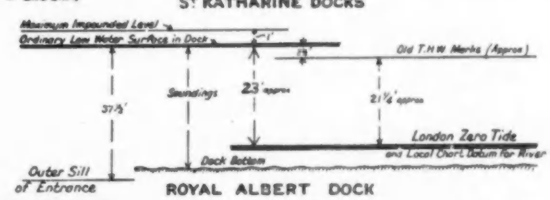
Two examples may be given of the application of these principles to dock charts:—

1. **St. Katharine Dock.**

As the surface level in this dock is very frequently 5-ft. below Trinity High Water the soundings should be taken from that level which is equal to $16\frac{1}{4}$-ft. above London Zero Tide, and 23-ft. on the outer sill of the entrance.



ST KATHARINE DOCKS



ROYAL ALBERT DOCK

2. **Royal Docks.**

The water in this system of locks is impounded to maximum height of 2-ft. 6-in. above Trinity High Water but is frequently only 1-ft. 6-in. above it. Therefore, the datum of soundings might well be say 23-ft. above London Zero Tide and $1\frac{1}{2}$-ft. above the old T.H.W. marks, and $37\frac{1}{2}$-ft. over the outer sill of Gallions Lower Entrance.

8. Dock Entrances.

Each dock entrance has a tide gauge cut in the masonry alongside the entrance gate and all who use the entrance know at any moment the height of the water over the sill at any stage of the tide.

But to find the water over the sill of any entrance from the published particulars and from the side tables is unnecessarily difficult.

Tidal Levels of the Thames—continued

For example in the tables giving the dimensions of entrances the depth of the tide prediction zero below the sill of the entrance is not given. The depth of the sill below Trinity High Water must be found in one part of the book and the depth of the tide zero found in another part, and the difference which is the only really valuable dimensions required, and which is a fixed value for all time, must be found by calculation.

That this defect in the tables is a real one is shewn by the publication of tide tables **by private firms,** giving these vital dimensions or constants.

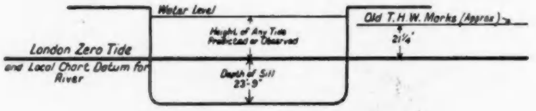
The writer submits that if the depths of sills are published with reference to the suggested London Zero Tide, the really necessary dimensions could be found, very simply:—

For example:

(1)	The sill of King George V. Dock Entrance would be given as a depth below Zero Tide of	**23.75 feet**
(2)	The predicted height of tide on a given day would be, say:—	**23.2 feet**
	therefore, the depth of water would be the sum of those two figures:—	**46.95 feet**

Note: The existing T.H.W. marks on this entrance are only $11\frac{1}{4}$-ft. above Newlyn Datum.

The simplicity of this will be evident to anyone who has attempted to find the same information from the usual tables of dock particulars.



KING GEORGE V. DOCK, ENTRANCE LOCK.

9. General Engineering Work.

It is hardly necessary to say that for general engineering and survey purposes the use of Trinity High Water is entirely obsolete, as such work is always carried out by reference to the bench marks of the Ordnance Survey.

But, as already mentioned, where such work must be related to the water levels and tides the use of the suggested London Zero Tide would provide a convenient link between tidal data and general civil engineering work.

Acknowledgment

The Author acknowledges the kindness of the Port of London Authority in consenting to the publication of this article and the assistance given by the Corporation of the City of London, the Corporation of the Trinity House, the Royal Society and the Director-General of Ordnance Survey.

The opinions expressed are entirely the personal opinions of the Author.

Death of Retired Canal Engineer.

The death has occurred at Canal House, Ardrishaig, Argyll, of Mr. Edward A. Bly, M.B.E., who for 20 years had been engineer and manager of the Crinan Canal, and who was well known to many West of Scotland yachtsmen in their journeys through the canal. Mr. Bly served for a number of years, including the period of the last war, on the staff of the Admiralty, but later joined the Ministry of Transport, and he became engineer and manager of the Crinan Canal in 1921, when the canal's administration had been taken over by the Ministry. He held the post until 1939, when he retired, but in 1942 he returned to the managership on war-time service. He received the M.B.E. several years ago, Mr. Bly was a native of Lowestoft, and was 70 years of age.

Legal Notes

Damage to Cotton Cargo during Discharge

The liability of a stevedoring company for damage to a cargo of cotton through being stained by carbon black during the discharge of a ship at Birkenhead Docks was the subject of an action heard at the Liverpool Assizes on April 15th. The facts of the case are set out in the Judgment delivered by Mr. Justice Hilbery, which, as reported in *Lloyd's List,* is given below. The plaintiffs were eleven cotton firms, owners and consignees of the cotton, and the defendants, Mrs. B. M. Coker, widow and representative of the late Alfred Coker, of Liverpool, and the Mersey Ports Stevedoring Company, Ltd., also of Liverpool.

Judgment.

Giving judgment, Mr. Justice Hilbery said that in March, 1940, the steamship *Nidaholm* began discharging at Birkenhead her cargo, which consisted of 5,000 bales of cotton and 30,000 bags of carbon black, and the claim of the plaintiffs was that the two defendants, or one of them, failed in their duties as master porters and did not take proper precautions to protect the cotton from damage by staining by the carbon black. Captain McClure, of the Mersey Ports Stevedoring Company, had said that for 20 years there was an arrangement with Mr. Coker under which, when Mr. Coker had a ship, Captain McClure was appointed working master porter. His Lordship stated that he was quite unable to find that it had been established that Mr. Coker appointed himself master porter of the vessel and only called upon the stevedoring company, so far as the master porter's work was concerned, to perform for Mr. Coker the actual work which a master porter should perform, and he held that there was not sufficient evidence to justify the inference that Mr. Coker ever appointed himself master porter of the vessel.

Carbon black was very greasy and very light, and had qualities which made it stain anything it came into contact with, and there were special regulations in connection with the handling of carbon black. There was no sort of effective screening between the carbon black and the cotton in the after hold of the ship, which was ill-adapted for that sort of mixed cargo, which, in his Lordship's opinion, had been badly stowed. Bags containing carbon black were ripped by the frames of the ship against which they rested. The real clue to the case was that the Mersey Ports acted as both stevedores, in which capacity they owed a duty to the shipowners, and as master porters, in which capacity they owed a duty to the consignees to protect the cargo from damage.

After 9,000 bags of carbon black had been landed, the dock shed was everywhere covered with carbon black, and in those cricumstances the stevedores did what seemed to his Lordship about as bad a thing as could be done—they started to discharge the cotton into that shed, which was a wholly unfit place for the storage of cotton. The cotton ought to have been discharged first, and steps should have been taken to hurry the consignees to take delivery and then a minimum amount of damage would have been done to a minimum number of bales. The stevedoring Company could not point to a single extraordinary precaution taken by them. They should have obtained barges and discharged the carbon black overside. While the Mersey Ports Company were concerned to bring about a quick discharge of the vessel in the interests of the shipowners, they did not make any effort to protect the interests of the consignees, and his Lordship was satisfied that a considerable amount of damage was done to the cotton while in the shed as a result of the failure on the part of the Mersey Ports Company to exercise the necessary care.

Mr. Justice Hilbery also held that a certain percentage of the damage to the cotton was done before the bales ever got into the hands of the Mersey Ports Company, but he had not to decide what that percentage was. Another tribunal would decide the extent to which the cotton was damaged through the failure on the part of the master porters to discharge their duties and that tribunal would assess the consequent damage in a sum of money. There would be judgment against the Mersey Ports Company for the plaintiffs for such damages as were found to be due to the breaches of duty on the part of the Mersey Ports Company, who would also pay Mrs. Coker's costs.

Port Facilities, Wharves, Docks and Terminals

*Post-War Need of Modern Installations in the United States**

By CHESTER H. MARSHALL.
Gulf Coast Director, U.S. War Shipping Administration.

Development in Steamship Cargo Carrier Types.

A TIMELY privilege I feel is granted in affording me this opportunity to say a few words that I earnestly hope will receive your careful thought in progressing your plans for the future of the well being of our people in the field of transportation. My subject is Docks and Wharves.

As all of us know, more recently great strides have been made in the development of advanced types of steamship cargo carriers; greatly accelerated to-day. Fortunately, early study was given the pressing need for improved types of vessels. A long range programme was enunciated and long since has been actively in effect. The preponderance of the cargo ships of to-day for operation on the high seas, both in foreign and domestic trades, are larger vessels essentially in cargo capacity, beam and length; the cargo capacity exceeding by about one-third that of the old type with which all of us are familiar; requiring the use of multiple sets of cargo gear and certainly ample wharf shed space to assemble at one time a greater proportion of a ship's cargo. The older vessel had a beam of 54-ft.; the new a beam of 63-ft. The length has gone up from 427-ft. to 468-ft. These are figures for the new intermediate design. Many will be larger. To-day as in the days to come, a fast turn around is all important. Wharves and docks must be of easy access, with sufficient space to assemble and faciliate the handling of freight both from the shore and from the water; mooring, docking and undocking.

COMPARATIVE VESSEL DATA

	Typical Vessels		
Built	1900	1920	1943
Length ...	406-ft.	427-ft.	468-ft.
Beam ...	48-ft.	54-ft.	63-ft.
Draft (Loaded) ...	22-ft. 6-in.	24-ft.	27-ft. 6-in,
Gross Tonnage ...	4504	5627	6165
Decks	Wood	Steel	Steel
Deadweight ...	3,750 tons	8,555 tons	10,850 tons
Speed	10 knots	10 knots	16 knots
Bale Cubic ...	269,400-ft.	436,000-ft.	568,000-ft.
Cargo Hatches ...	3*	5	5
Side Ports ...	3	0	0
Measurements—Largest Hatch...	14-ft. by 12-ft.	31-ft. 6-in. by 21.ft.	45-ft. by 20-ft.
Cargo Gear (Sets)	3	5	8
Nominal Rate of Handling Freight Per Ship Hour...	100 tons	125 tons	200 tons
Per Work Day (8 hours) ...	800 tons	1000 tons	1600 tons

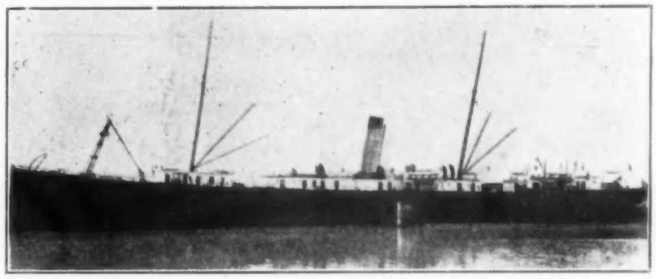
* And 3 Complementary Side Ports

WHARF SPACE

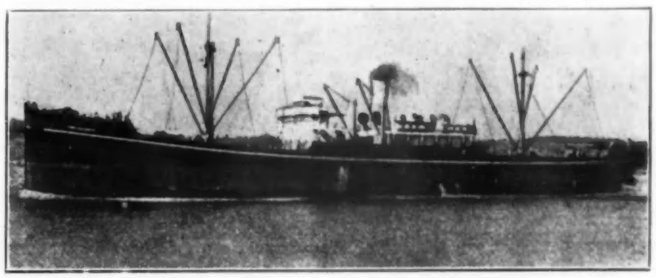
Dock space required to handle a full cargo—*one way*—by typical vessels, based upon block stowage on the wharf 10-ft. high, plus nominal allowance for roadways and aisles.

Vessel Era	Required dimensions of Wharf Shed for Cargo
Vessel built about 1900 (total deadweight 3750 tons)	410-ft. long by 100-ft. wide
Vessel built about 1920 (total deadweight 8555 tons)	430-ft. long by 152-ft. wide
Vessel built in 1943 (total deadweight 10,850 tons)	475-ft. long by 200-ft. wide

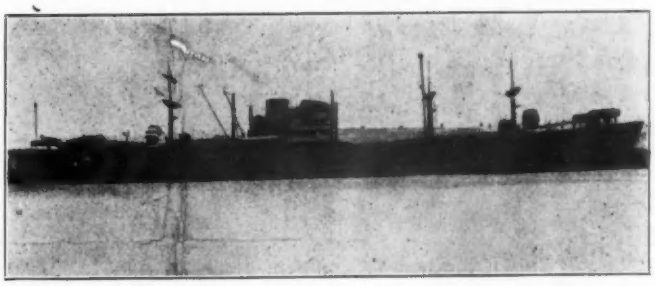
We are now engaged in a great struggle and every day a greater appreciation and value attaches to the availability of more and more docks of greater capacity. While so engaged at this time we cannot help but give some thought to our problem of the future. With the advent of peace, devastated areas across the seas will rise up again, and, starting from scratch, port facilities there cannot but be of the most modern construction and built adapted to the change in needs brought about by the change in design of ships, particularly involving cargo capacity, dimensions and cargo handling gear installed. Here at home some progress has been made, but it would appear that much more is necessary. Fortunately, here in New Orleans and in some of our other ports, we have a model system of docks to be envied; extending for miles up and down the waterfront; and of great depth, or shall I say width, finished expansively with smooth working surfaces of maximum load capacity, and served direct by the rails of the carriers; but improvements are always needed. Wide working aprons near to the ships are afforded, fitting in nicely with the double cargo gear employed at each hatch. Each hold is that much larger to-day and to gain the advantage we must strive to stay within the limits of the ship's length in the shed, and that means greater and yet greater depth or width of shed.



Coastwise Vessel constructed about 1900, total deadweight 3,750 tons.



Intercoastal Deepsea Coastwise Vessel constructed about 1920, total deadweight, 8,555 tons.

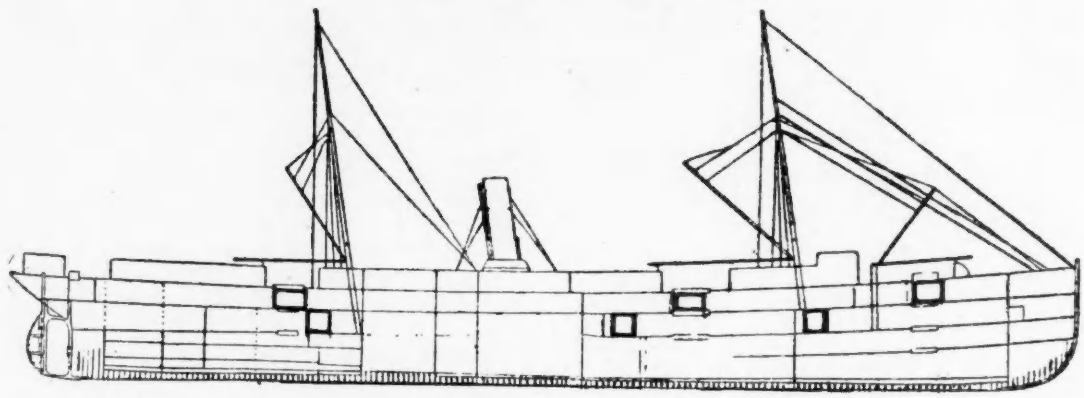


A modern all-purpose vessel of 1943, total deadweight 10,850 tons (Eight Sets of Cargo Gear).

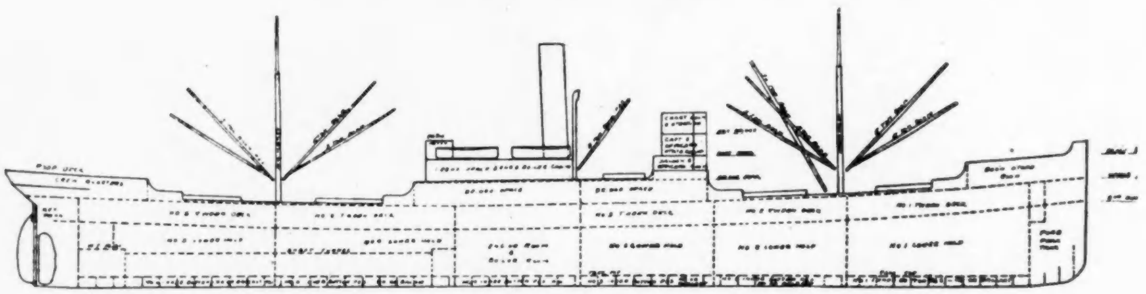
*Address delivered to the American Association of Port Authorities, New Orleans, La., October 21st, 1943, slightly abridged.

Port Facilities, Wharves, Docks and Terminals—continued

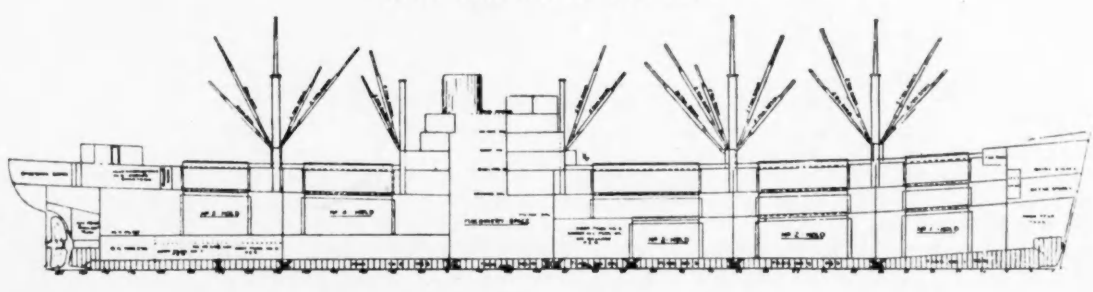
EVOLUTION OF TYPE OF VESSEL



INBOARD PROFILE COASTWISE VESSEL BUILT ABOUT 1900
TOTAL DEADWEIGHT 3750 TONS.



INBOARD PROFILE INTERCOASTAL—COASTWISE—OFFSHORE
VESSEL CONSTRUCTED ABOUT 1920.
TOTAL DEADWEIGHT 8555 TONS



A MODERN ALL-PURPOSE VESSEL OF 1943.
TOTAL DEADWEIGHT 10,850 TONS.
(EIGHT [8] SETS OF CARGO GEAR.)

Packing and shipping methods have changed, effecting savings, with the increased ability of transportation to serve. Carrying and lifting equipment has been developed to keep pace. A whole machine of great bulk and weight moves to-day where the parts moved yesterday, but we must provide these carriers both on the land and the water, space and facilities to permit for the best use of their applied improvements if we are to benefit in full measure. We now have a vessel economical of operation, with tremendously greater carrying power and fitted with the machinery necessary to faciliate loading and unloading, but we must keep pace ashore and provide the docks where necessary. The life of a wharf is substantial. Many of our piers and wharves throughout the country were designed for the ship of an older day; the horse and buggy days. Indeed yeoman service of the first order has been rendered, but our sailing vessels in all their glory have long since passed the task of our already out-moded earlier type of cargo steamer.

The New Era.

A new era is here and we must meet the situation. This is true in all forms of transportation. Railroad equipment is in the making calling for faster release at terminals. Better connections with rails will do much good. Our highway vehicles have been developed to a high degree. Dispatch is the watchword. Check on our piers and docks. I dare say frequently they are hard put to permit a modern over-the-road truck to come down the pier account lack of clearness, let alone room to turn around on the pier when they can get on it. Some of these trucks and trailers will reach up to 50-ft. The narrow pier is outmoded. Too frequently a pier is just too short to comfortably accommodate the length of one of our new longer ships and elsewhere just misses mooring length for two. Even docking space for two ships on one side of a wharf is a far cry from sufficient dock space for each cargo under cover with the larger ships. The Teredo and Father Time have also been

Port Facilities, Wharves, Docks and Terminals *(continued)*

busy. Maximum load per square foot of wharf shed in its restrictions holds us back. It is to be expected that in the future a greater variety of cargo than ever before will pass over our docks, meaning more shed space. The wooden pier dock served its purpose in the days of the horse as did our cobble stone streets and the narrow piers served man in the days of the hand truck, but to-day the mechanical aids to labour in all their efficiency call for wide unobstructed expanses of smooth concrete surfaces and direct connections with other carriers. Ability to assemble on the wharf ready for loading the maximum of the right kind of cargo, weight or measurement, wet or dry, at the right time makes for more efficiency and maximum loading, thus affecting the measure of the rate of freight.

Bottlenecks must be eliminated, both as between the dock and the ship, and between our transportation arteries and the wharves. This calls for modern piers of the greatest possible length and breadth, so constructed as to provide for a maximum of facility. Congestion of transportation feeders—rail, truck and water, must be avoided and broad avenues of approach to piers must be maintained. Time at the pier waiting to load and unload equipment to and from the hinterland must be reduced to a minimum. To save time and effect economies with a ship, not too much larger in actual form than the old type, but much larger in carrying capacity both as to volume and weight, we are faced with the necessity of even reducing the stay-in-port of this new type ship over that of the old at its best, with, I repeat, about one-third more tonnage to be handled. This demand is made on us if we are to profit by the ingenuity of our shipyards. As in the past, our national well-being will continue substantially dependent upon our retention and expansion of water transportation, not only in our foreign trades, but in our domestic trades. A strong national merchant marine is no longer an empty phrase, as we are proving to-day. We must always be on guard.

Post-War Planning in Reference to the Smaller Welsh Ports

Plea for Government Consideration

A memorandum by Councillor T. Wynne Thomas of Aberdovey on the subject of post-war planning for the small ports lying on the West Coast of Wales has been submitted to, and its recommendations adopted by, the County Council of Merionethshire.

The terms of the memorandum are as follows:—

"(1) That the Merioneth Rural Industries Sub-Committee recommends to the Merioneth County Council that a resolution be forwarded to the Welsh Advisory Council for Post-war reconstruction urging the Council to lay before H.M. Government a plea for a survey of the small ports on the West Coast of Wales, with a view to exploring the possibilities for their development, and respectfully suggesting that post-war building development could be greatly aided by the establishment of factories for the manufacture of concrete for building purposes at some of these smaller ports, utilising for such manufacture the sand, water and gravel already available there in vast quantities. And, that the County Council also point out that the utilisation of the aforesaid small ports as auxiliary to the larger ports, such as Liverpool and Cardiff, would greatly ease the strain that will undoubtedly be placed upon them.

"(2) That the counties of Cardigan and Caernarvon be asked to support these representations, the small ports concerned being:—Caernarvon, Pwllheli, Portmadoc, Criccieth, Aberystwyth, Aberayron, New Quay, Cardigan, Fishguard, Barmouth, Aberdovey.

"(3) That all the Counties of Wales be asked to co-operate, so that a complete survey of all the Ports of Wales from the Dee to the Severn be undertaken by the Government Department concerned, through the good offices of the Advisory Council, so that the ports of Flintshire, Anglesey, Carmarthenshire, Denbighshire, Pembrokeshire, Glamorganshire and Monmouthshire will all pull their weight in essential coastal transport as of yore."

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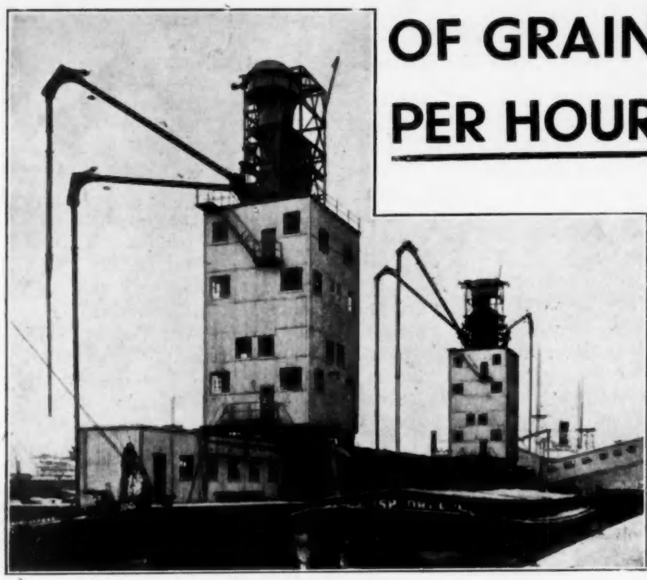

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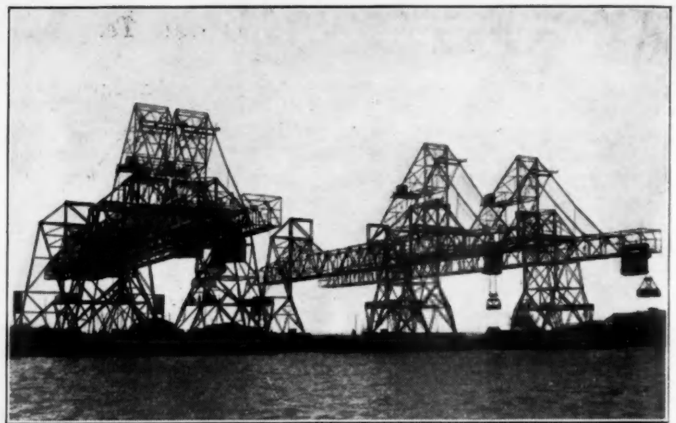

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